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ABSTRACT

This guide is one of a set of 10 science guides, each covering a separate grade in Manitoba, together covering kindergarten through grade 9. The guides have been designed to provide a framework for building scientific concepts and developing the learning of process skills. They replace an earlier set of guides dated 1979. Each guide is essentially the same through the first 16 pages, after which the core units vary appropriately for each academic level. Three themes and units within those themes which are carried through the K-4 program include: (1) environmental interdependency and interaction-- microbes and ecosystems (grade 7); (2) matter and energy--light /physical properties/physical changes or matter (grade 7); and (3) earth, time and space--rocks, minerals and soils/the observable universe (grade 7). Appendices include: (1) K-9 program overview; (2) science processes development: K-9; (3) science processes development: problem solving, K-9; (4) objectives and concepts for STS interactions; (5) K-9 STS content; (6) uses of computers in science; (7) safety in science; (8) women in science; (9) science fairs; (10) basic equipment lists for grades 5-9; (11) directions for using the microscope; and (12) a copy of the response questionnaire for the K-9 program of studies. (KR)

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Manitoba Education and Training

1991

science: grade 7

interim guide

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science: grade 7

interim guide

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manitoba education and training

1991

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This guide was prepared by Manitoba Education and Training to provide students with some basic understandings and skills in science. The interim form of this guide has been developed on the basis of feedback from teachers during the period of 1988-89. The 5-9 science program has been designed to articulate with K-4 science and to provide basic concepts and skills which will be useful to students continuing in the sciences. This guide may be used in September, 1991, in place of the previous (1979) guide.

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INTRODUCTION

RATIONALE

The previous science curricula, designed during the period of 1976-78, were concerned with helping students to rationally process data within the context of a scientific knowledge which could sometimes be applied to student and environmental concerns. These emphases occurred because of the apparent needs of the middle years student, the impact of environmental and energy problems upon the aims of science education, and the potential effect of science and technology upon the student and society. Although the specifics may have changed since the 70's, the general needs of the 11-15 year old students and aims of science education which can satisfy these needs remain unchanged. However, the need to review an area of science education with a high impact upon students' future decisions, the increased effect of science and technology upon the individual affecting our need to understand this area, teacher feedback concerning the program, and other items have indicated a need to modify some of the emphases and design of the program.

During the last two years, teacher surveys relative to the K-6 and 7-9 science programs have been conducted. These surveys and a major Science Council report[1] indicated that a general or integrated science program should be retained which had a balance among major ideas that would aid students in applying them to his/her environment; and to provide a flexibility in the design of the program. In addition, the surveys indicated a need to review some of the space, environmental, and physical science units. Because the K-9 science program was reviewed, it was possible to examine the sequence and development of concepts and processes in such areas as the environmental theme. Thus, some units such as the Grade 7 unit on micro-organisms was modified to reflect a greater environmental emphasis.

Newspaper articles and television reports are constantly reminding us of the increasing impact that science-technology has upon humans and their environment. An introduction to the nature, strengths and limitations of science and technology occurs in this curriculum and is applied more fully in the senior years. For example, the science and technology of flight and possibilities of energy conservation are introduced and applied.

Students are bombarded with a tremendous amount of data which is sometimes conflicting and of uncertain validity. Consequently, they need skills to organize and evaluate information, and to apply scientific knowledge to life situations. In order to help students to become scientifically literate in today's society, this curriculum should begin to develop the following attributes:

- Understands scientific concepts and their applications in practical situations.
- Recognizes the strengths and limitations of science and technology and their applications to life management and societal decisions.
- Applies science processes, concepts, and values to problem-solving and responsible decisions.

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1 Science for Every Student. Science Council of Canada.

- Understands and respects the ethics of science and the relationship of science to other fields of learning.

- Maintains a positive interaction with their environment.

- Develops an interest in science-related skills which can be applied to lifelong learning.

AIMS (GOALS)

GOALS OF THE SCIENCE 5-9 CURRICULUM

In general, today's educational goals emphasize the need to help learners to achieve their potential as responsible individuals. These individuals will have acquired the knowledge and skills for understanding ideas and solving problems; developed respect for others, their cultures, and the environment; and remained an active learner with a productive future. The goals of science education contribute to general learning goals through experiences which help students to understand the nature of science and technology and the ability to apply their knowledge and skills to managing their lives. As a student progresses from Science 5 to Science 9, the following skills, knowledge and attitudes should be acquired:

1) An understanding and facility in applying the skills and processes of science.

   Processes of science include identifying a problem, observing, inferring, formulating models and experimenting. The complete list of processes can be found on page 24. In addition, an understanding of the nature and limitations of science will be developed.

   The psychomotor skills necessary for proper laboratory techniques and safe handling of equipment and materials are included.

2) A facility in problem solving using science.

   Students will be provided with opportunities to use scientific concepts and processes to define problems and reach conclusions. Some of the skills, which will be developed, include the ability to:

   - Recognize and define a problem, its central issues and assumptions.

   - Develop alternate solutions to a given problem.

   - Evaluate evidence including gathered data, print and non-print information, and the validity of conclusions.

3) The basic knowledge and attitudes* needed to function in a scientific and technological world.

   Concepts are provided in the areas of life-environment, earth-space, and physical sciences. Attitudes, to be developed, include a curiosity and interest in scientific phenomena, questioning of all things, respect for accuracy and precision, belief in cause-effect relationships, and suspension of judgment pending adequate data.

4) An understanding and appreciation of the relationship between science and technology and their relationship to society and the individual.

   Students will have opportunities to develop understandings such as:

* See Attitude and Values, page 3.

- The nature of science as a search for truth, with presently tentative understandings based upon both rational insight and chance discovery.

- The differences between science and technology and their abilities and limitations for solving problems.

- The recognition of potential implications for society of scientific discoveries.

The student is affected personally by the growth of scientific knowledge. The student should become aware of how the knowledge of science enhances personal life management. For example an understanding of such things as properties of matter and radiation, plants and animals, the environment and natural resources, chemical reactions, and appliances and machines will help students enrich and manage their own lives at school and in the future.

5) Respect for the environment and the relationship of science to issues and values.

Students will be provided with opportunities to develop a respect for living things, the nature of their interactions, and the potential effects of human decisions upon the environment. During the upper levels of the curriculum opportunities to use science information and skills to examine and clarify various social and environmental issues will be provided.

6) Awareness of the career opportunities in science and technology.

ATTITUDES AND VALUES

The student should develop positive science attitudes which can be either scientific or environmental in nature.

SCIENTIFIC ATTITUDES

1. Develop a curiosity about natural events that occur on Earth.

2. Become aware of the universe and its contents.

3. Recognize the impact of space research and space technology on communication, weather prediction, and spin-offs.

4. Value the differences that exist between organisms, including humans.

5. Foster an appreciation of technology on society.

6. Develop an awareness of how scientific research and development affect our lives.

7. Develop a concern for energy and the need to conserve energy.

8. Be aware of alternative forms of available energy.

9. Appreciate the impact of chemicals.

10. Develop a concern for safety in the home and school.

11. Deal with problems in an open-minded manner.

12. Use scientific knowledge and skills to clarify personal values.

ENVIRONMENTAL ATTITUDES

1. Appreciate the environment and the interactions of life forms within the environment.
2. Develop an awareness of threats to the environment such as greenhouse effect, acid rain and pollution.
3. Distinguish between the proper use and the misuse of chemicals on the environment.
4. Develop a responsible attitude towards managing and conserving the environment.

LEARNING THEORY AND PROGRAM DESIGN

The Science 5-9 program attempts to consider present knowledge of the intellectual and social development of middle years students and the nature of science education in designing the program. As illustrated in the aims, science education is concerned with helping students to apply concepts to their interpretation and management of their world. In the past, much has been written about intellectual development from the stage of focusing on the particular and concrete to the formal operational stage[2]. Although science education research has maintained its interest in developmental ideas, recent research has also been concerned with the efforts of students' preconceptions about the real world upon their understanding of the world as defined scientifically. A current perspective of learning maintains the view that learning is an active process with the following concepts[3].

- Students' conceptions, purposes and motivations influence the way in which they interact with learning materials in various ways. Those commonly held concepts of systems which are different from the scientific reality are called misconceptions.[4] For example, a common misconception about current electricity is that current is used up as it flows around a circuit.

- Learning involves constructing meaning as a continuous and active process. Although the meanings may appear to be incoherent to others, the student may not see the idea as incoherent. For example many young children believe that an object sinks more readily in deeper water.

- Meanings are stable; modification of a meaning is dependent upon a student's belief. Although students may be able to develop a new idea which conflicts with old, they are often reluctant to accept it and develop a new system of thinking. For example, some students in physics tend to associate constant force with constant motion and have difficulty in accepting that tables and walls, in static equilibrium, can exert forces.

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[2] Osborne K. Middle Year Sourcebook: Some Suggestions for the Education of Early Adolescents. Department of Education, Province of Manitoba, 1984.

[3] Driver, R. and Bell, B. "Students' Thinking and the Learning of Science: A Constructivist View", School Science Review, March, 1986, p. 443, 456.

[4] Eaton, J. F., Anderson, C. W., Smith, E. L. "What Students Don't Know. They Don't Know", Science and Children, April, 1983, p. 7-9.

- Some meanings are shared i.e. commonly held ideas can be identified. For example, research indicates that children have a tendency to identify heat with temperature and to consider heat as having fluid properties. Heat transfer is better understood when a temperature change occurs (conduction) than when it does not (change of state)[5]. In regard to plant nutrition, many students associate food getting with the soil and have little understanding of the relationship between photosynthesis and other physical and chemical processes[4]. After all don't we say "Give that carnation some plant food?"[6]

The above learning assumptions and research findings have a number of implications for the design and teaching of science.

IMPLICATIONS OF LEARNING THEORY TO THE DESIGN AND TEACHING OF THE SCIENCE PROGRAM

Learning theory has been related to the design of the Science 5-9 program and teaching strategies in the following ways:

- The program design has attempted to provide a developmental sequence of tasks and skills whereby students are required to process data and variables. An increase in the complexity of the variables which are considered and the degree of student input or control is increased e.g. the testing of a consumer product or of a hypothesis.

- Variation among students is considered within the program design in two ways. Firstly, the program provides suggestions for a wide range of activities. Secondly, the design has been modified in order to provide additional time. The time is critical for encouraging students to hypothesize and generate models, test assumptions, and to explore concepts with others.

- A need exists to apply concepts in a variety of real-world or practical situations. For example, many students believe that steel and wood in a room are at different temperatures. Students should examine heat transfer and temperature with a variety of materials. The science-technology-societal theme encourages application in topics such as flight or the design of models.

- Language development correlates highly with the development of reasoning skills according to a number of research studies. Teachers should consider the following activities to support the development.

  a) Incorporate reporting tasks where connective terms such as "since, hence, similarly" are required to summarize results.

  b) Use examples that require formal reasoning with concrete situations.

  c) Provide practice in visualizing and verbalizing concepts and ideas.

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[5] Brook, A. et al. Aspects of Secondary Students' Understanding of Heat. Centre for Studies in Science and Mathematics Education, The University of Leeds, 1984.

[6] Bell, B. et al. Plant Nutrition. Centre for Studies in Science and Mathematics, University of Leeds, 1985.

- Since students are developing more sophisticated understandings over time, the curriculum design has included aspects of a spiral curriculum within some of the themes.

- Pupil interaction with concrete situations requires that teachers spend the necessary class time getting students to make sense of their experiences and by helping them connect activities to past and future science knowledge. This can be supported by determining students' ideas (including misconceptions) early in a unit creating situations whereby they must clarify their ideas, evaluate alternatives, and apply them in a range of situations. This can be achieved by focusing on the processes rather than on the content of science.

SELECTION AND USE OF CURRICULUM MATERIALS

In this revised course, the curriculum consists of the objectives of each unit as listed in the expanded outline. The materials presently in the schools as well as the materials which will be recommended on an ongoing basis by the Department of Education and Training are to be used by students and teachers to develop the concepts or skills specified in the objectives. Teachers are encouraged to seek out additional materials which will provide them with assistance in planning their lessons.

GENERAL PROGRAM OVERVIEW AND ESTIMATED TIME ALLOTMENTS

THEMES	5	6	7	8	9
ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION	Adaptations to Environment	Interactions of Populations with Environment	Microbes and Ecosytems (22)	Cells and Organ Systems (24) --- Plants and the Environment	Reproduction and Heredity (18) --- Plant and Animal Interactions (24)
CHANGES IN MATTER AND ENERGY	Electric Charges --- Force and Motion --- Physical and Chemical Changes	Force and Motion --- Machines ---	Light (22) --- Physical Properties (16) --- Physical Changes of Matter	Heat (22) --- Alternative Energy Forms (16) --- Flight (22)	Force, Work and Motion (18) --- Chemical Interactions (18)
EARTH, SPACE AND TIME	Changing Earth	Weather --- Earth in Space	Rocks, Minerals and Soils (24) --- The Observable Universe (16)		The Changing Earth's Crust (22)

NOTE: Grades 5 and 6: Recommended 30 minutes per day for science. Units are of approximate equal length.
Grades 7, 8 and 9: Estimated time (hours) per unit.

SCOPE AND SEQUENCE

THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
INTER-DEPENDENCY AND INTERACTION	LIVING AND NON-LIVING . characteristics . plants as living organisms, growth needs	ANIMALS . animal characteristics . comparison of different animal properties . animal care OURSELVES . variations and comparisons among people characteristics	ORGANISMS IN THE ENVIRONMENT . properties unique to six animal groups (insect, birds, mammals...) . properties of deciduous trees and plant needs . organisms - response to stimuli . animal-plant characteristics and habitats . man's interactions	LIFE CYCLES . complete and incomplete metamorphosis . animal behaviour and instinct	POPULATION INTERACTIONS . nature of a population and habitat . animal interdependency herbivores, carnivores, omnivores, and predator-prey . food recycling, food chain and web . population - environment interactions . human interactions

SCOPE AND SEQUENCE

THEMES	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
INTER-DEPENDENCY AND INTERACTION	ADAPTATIONS TO THE ENVIRONMENT . structural and behavioural adaptations (plants and animals) . Adaptations related to distribution, reproduction and survival	INTERACTIONS OF POPULATIONS WITHIN THE ENVIRONMENT . populations needs and competition . Producers and consumers . Human dependency and interaction with environment	ENVIRONMENT . ecosytems-interaction of biotic and abiotic factors . yeast is a decomposer . Factors affecting population growth in a yeast culture . microorganisms - benefits and harm	ENVIRONMENT . factors involved in photosynthetic process . growth and soil . plant respiration . plant role in environment and with man CELLS AND ORGAN SYSTEMS . organization - cell to system . structure and function - circulatory and respiratory systems . Health problems and solutions	INTERACTIONS . interactions-competiton to commensalism . energy changes in food chains to pyramids . Nature of succession . Management REPRODUCTION AND HEREDITY . asexual and sexual cellular reproduction . human reproductive system, structure and cycles . variations in human traits . genetic control and prediction

SCOPE AND SEQUENCE

THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
MATTER AND ENERGY	PROPERTIES OF OBJECTS . senses help determine properties of objects (size, colour, shape, texture, hardness, weight) . classification and identification from properties . change in properties	PROPERTIES OF MATTER . materials have unique properties, can identify . characteristics of solids and liquids . changes in solids' properties (dissolved, heated) . patterns and order in change	FLOATING AND SINKING . objects vary in ways they float . different liquids and shape affect an object's floatation . depth of a liquid has no effect . designs of objects can be tested for floatation	CHANGES IN MATTER . matter made of parts . particles in liquids and gases . separation in mixtures . liquids vary in properties . nature of physical change AIR AND AIR PRESSURE . properties of air . warm air rises . air contains water vapour HEAT AND TEMPERATURE . heat energy causes motion . expansion and contraction . temperature measurement . conductors and insulators . absorption - colour	SOUND . sound caused by vibrations, pitch . sound travel - direction, loudness . sound conductivity . sound pollution and control STRUCTURES . cell structure and characteristics . skin and skeletal structures - materials, size and strength . size, shape design and materials affect a structure's strength ELECTRICITY . single cell circuit and switch . several cells circuit (one bulb) . series and parallel circuit . conductors, insulators and the light bulb

THEME	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
MATTER AND ENERGY	CHEMICAL AND PHYSICAL CHANGE . properties identify objects . characteristics of physical change (shape, size, state mixtures) . chemical change characteristics ELECTRIC CHARGES . static electricity - nature and production . electric current - chemical production, electro magnetism, applications FORCE AND MOTION . unbalanced forces on motion . weighing objects - balance beam and spring scale . transmission of forces and test of strength	FORCES AND MOTION . force on an area . factors affecting floatation and design of floating objects FORCE AND MACHINES . effort and resistance relationships (six simple machines) . lever, inclined plane and pulleys relationships are quantitative . complex machines contain two or more simple machines	PHYSICAL PROPERITIES . changes in state, water cycle . fusion, vapourization and temperature . factors affecting solutions and separation . properties of industrial products, testing LIGHT . transformation of light energy . light transmission - reflection and refraction . light and colour . uses of lens	HEAT . heat and temperature . energy transformations to heat . heat transfer and applications . expansion, contraction and applications . alternative sources ALTERNATIVE FORMS OF ENERGY . formation or production of fossil, solar, nuclear, wind, and hydro-electric energy . cost-benefits of alternatives FLIGHT . factors affecting . lighter-than-air flight . forces and controls on heavier-than-air flight . design factors . flight in space	CHEMICAL COMPOSITION AND CHANGE . characteristics of chemical change . elements, atoms, compounds and reactions . conservation of matter . acids and bases, characteristics and tests . household chemistry and safety FORCE-WORK MOTION . unbalanced forces, gravity . quantitative relationships within simple machines . mechanical advantage, work and efficiency . friction effect on efficiency

SCOPE AND SEQUENCE

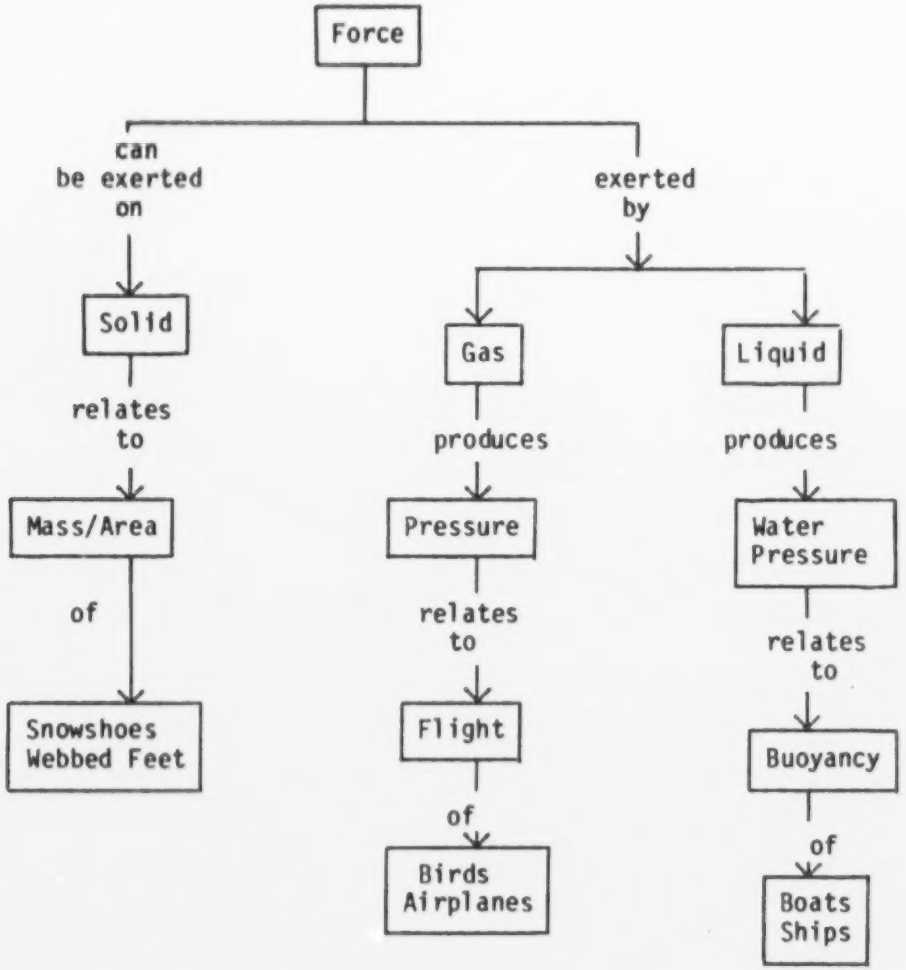
THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
EARTH, TIME AND SPACE	SIZE, POSITION AND TIME . size comparisons (non-standard units) . reference points and position . ordering of events	COMPARING AND MEASURING EVENTS . regular and irregular events . events in time sequence . time measurement (non-standard and standard units)	MEASURING TIME AND POSITION . time measurement - standard units . size and distance - standard units . position location measurement LIGHT AND SHADOWS . light position and size, nature of shadows	SUN, EARTH AND MOON . light reflection and conduction . sun - object shadows . relative position - night and day, moon phases THE OBSERVABLE UNIVERSE . location using a coordinate system moon characteristics and earth-moon interactions . characteristics of sun as a star . constellations, galaxies . technology of space	WATER AND LAND . erosive effects of water . factors effecting erosion . absorption of water into land . water cycle . conservation

SCOPE AND SEQUENCE

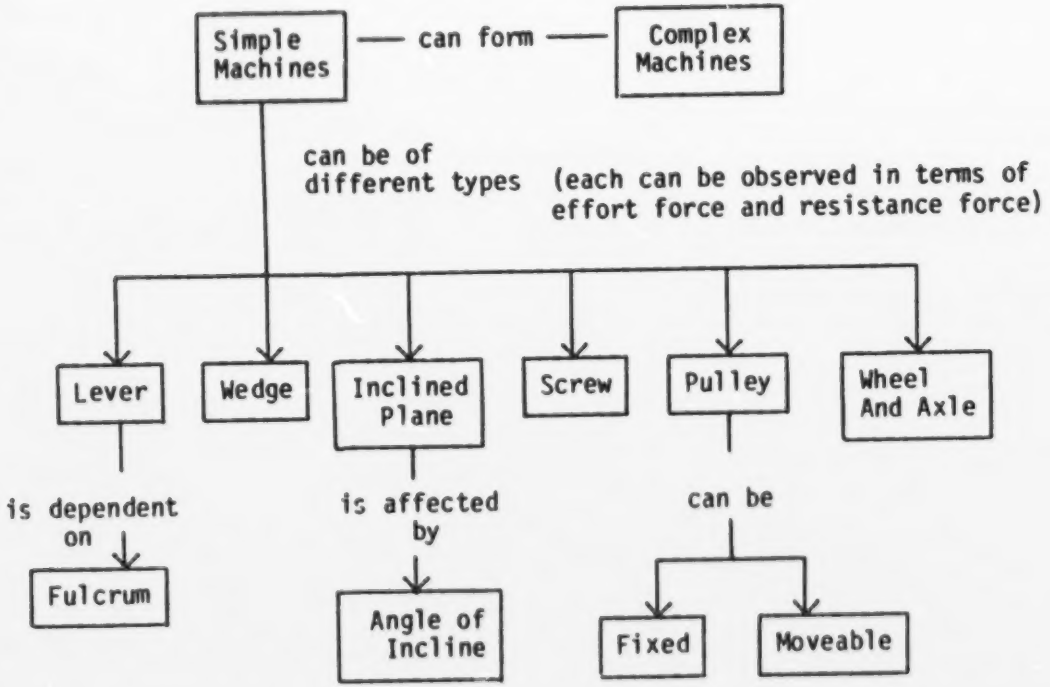
THEME	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
EARTH, TIME AND SPACE	CHANGING EARTH . rocks and minerals . sedimentary rock formation . fossil formation	EARTH IN SPACE . rotation and time . revolution and seasons . planets in the solar system . technology for observation WEATHER . factors affecting air movement . humidity, air movement relates to cloud formation and precipitation . weather and air masses, prediction and technology	ROCKS, MINERALS AND SOILS . igneous, sedimentary and metamorphic rocks . the rock cycle . testing of minerals . uses of rocks and minerals . nature and production of soil . erosion and soil management THE OBSERVABLE UNIVERSE . location using a coordinate system moon characteristics, and earth-moon interactions . characteristics of sun as a star . constellations, galaxies . technology of space		THE CHANGING EARTH'S CRUST . Alternate theories for continental structure . evidence for plate tectonics theory . technological support . relationship of plates to volcanoes, earthquakes and mountains

GRADE 6

CHANGES IN MATTER AND ENERGY: FORCES AND MOTION

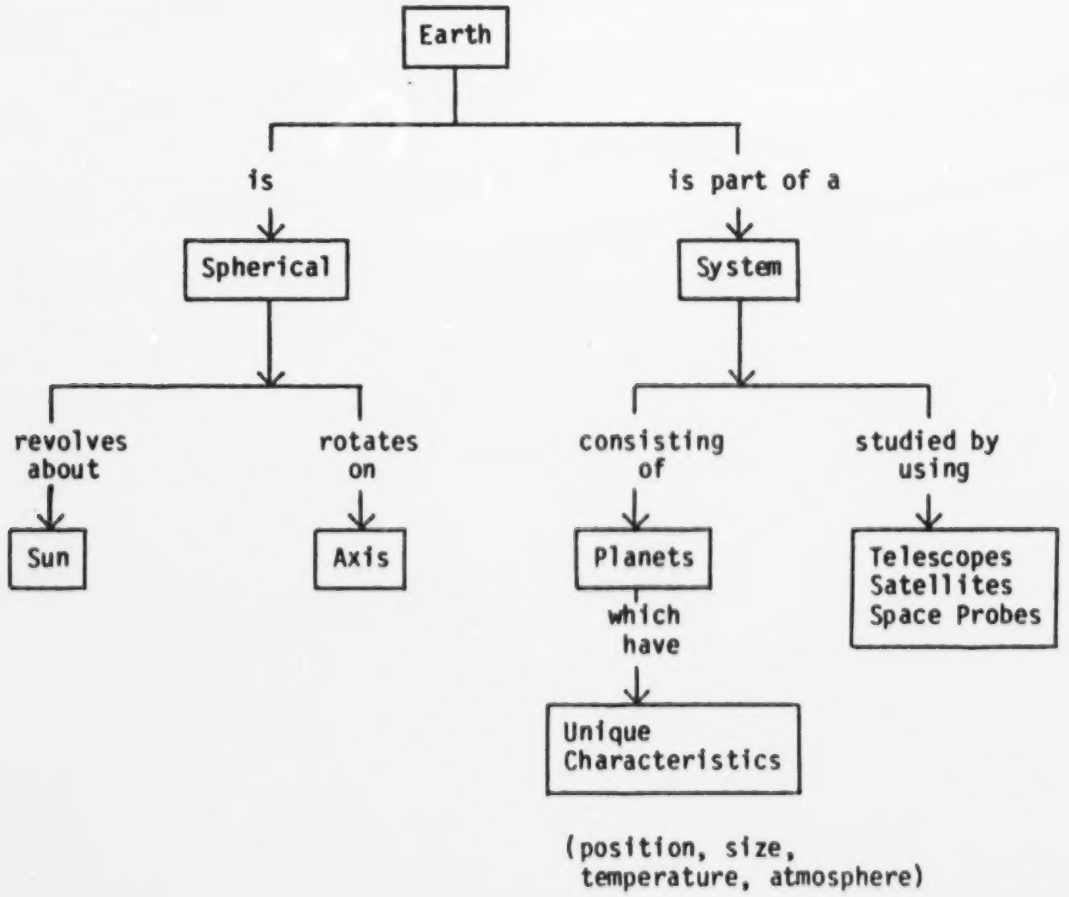


GRADE 6: CHANGES IN MATTER AND ENERGY: SIMPLE MACHINES



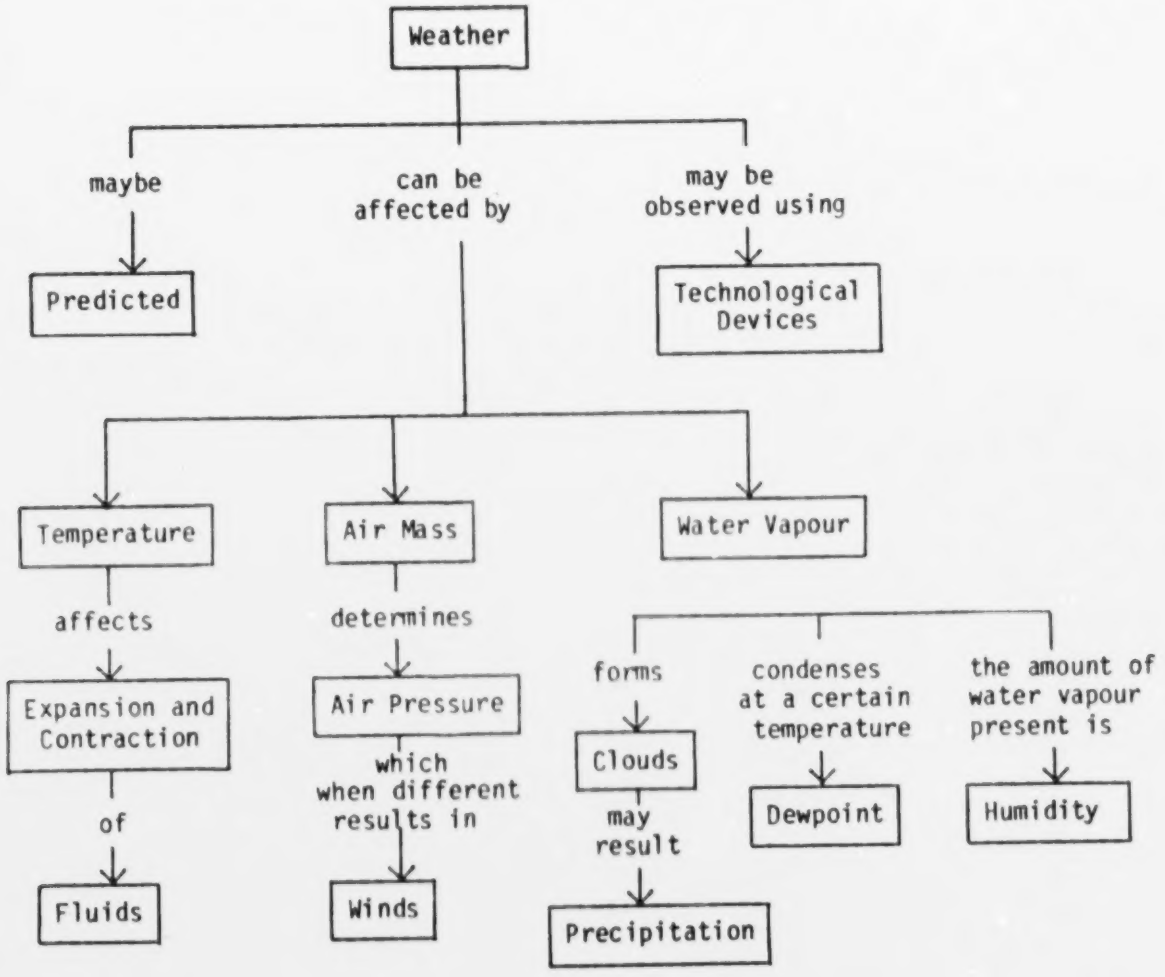
GRADE 6: EARTH SPACE AND TIME: THE EARTH AND THE SOLAR SYSTEM

EARTH AND THE SOLAR SYSTEM



GRADE 6: EARTH, SPACE AND TIME: WEATHER

WEATHER



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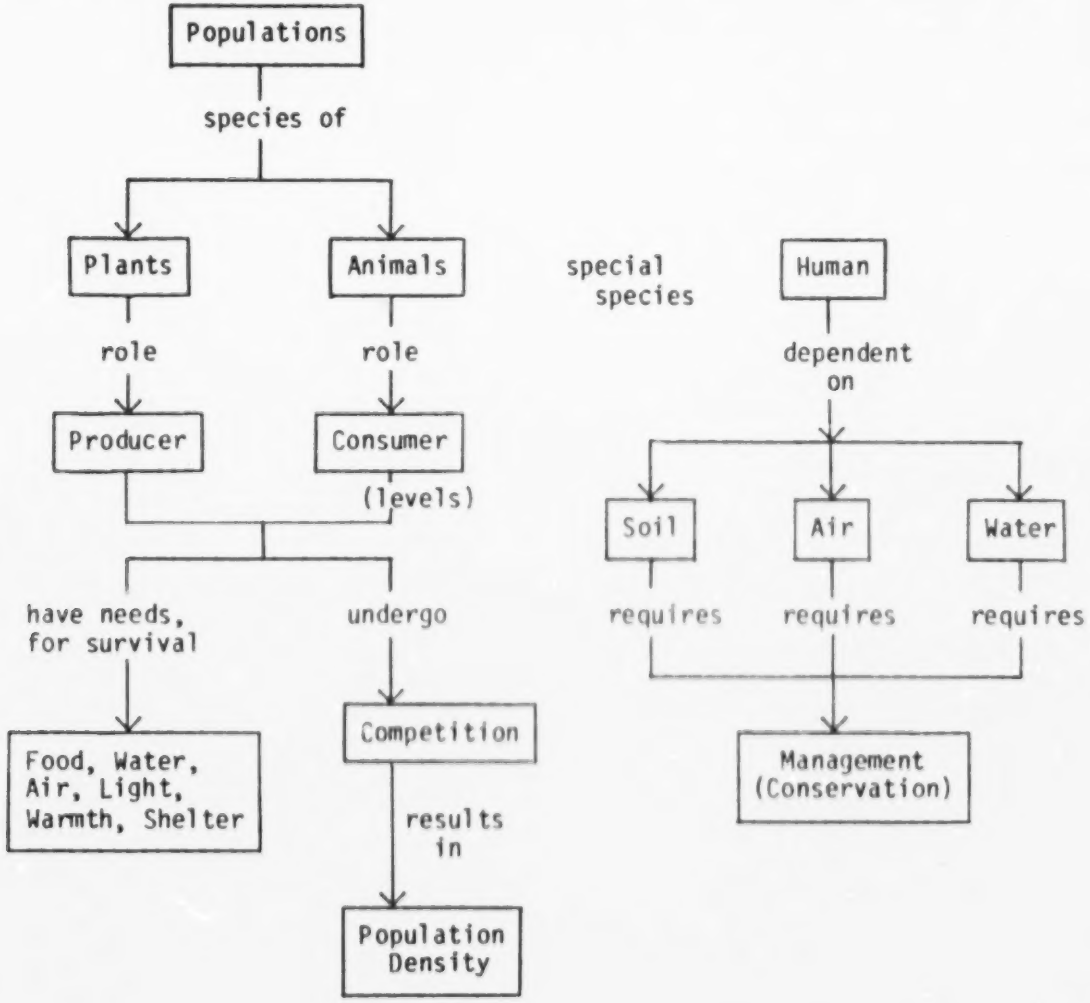
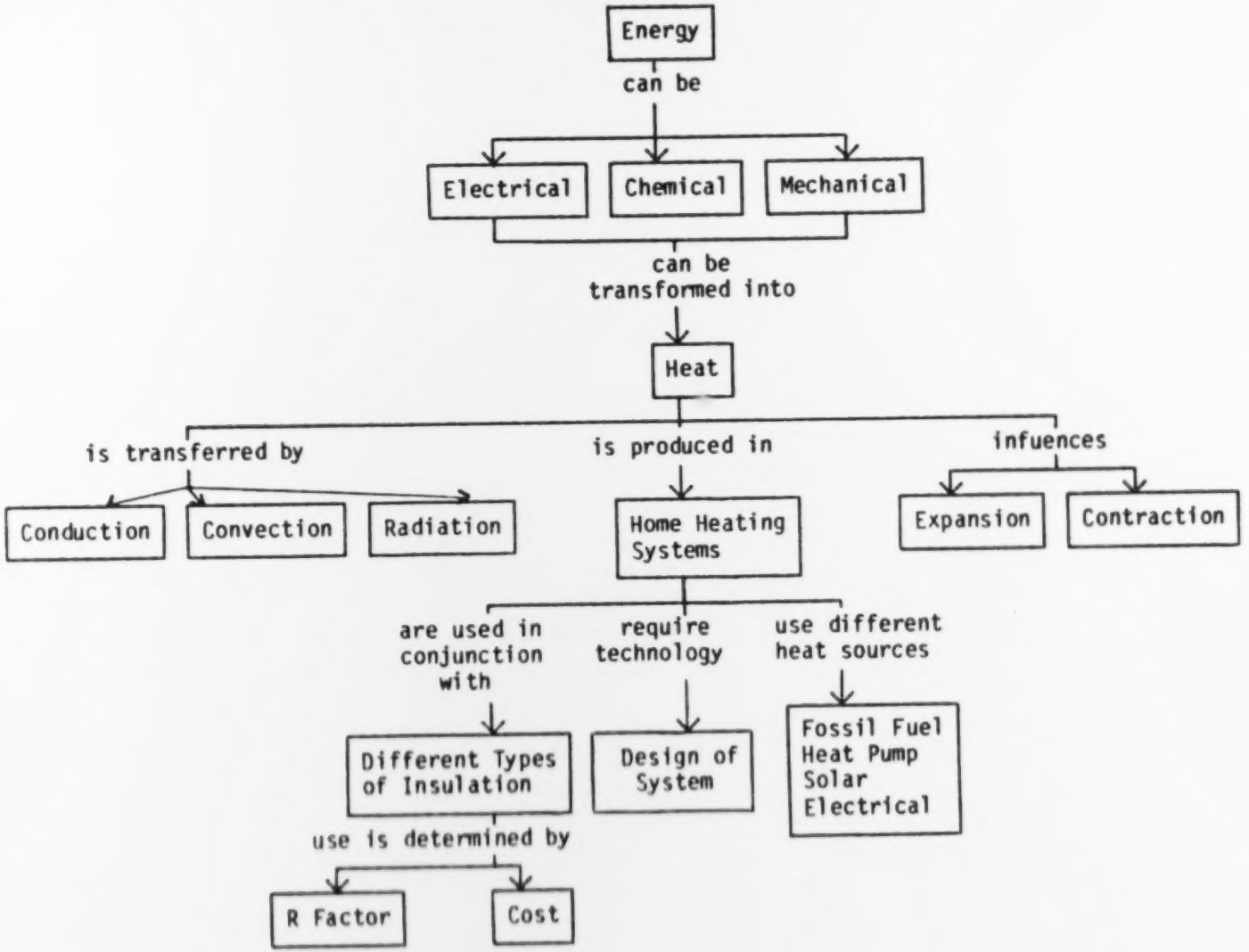
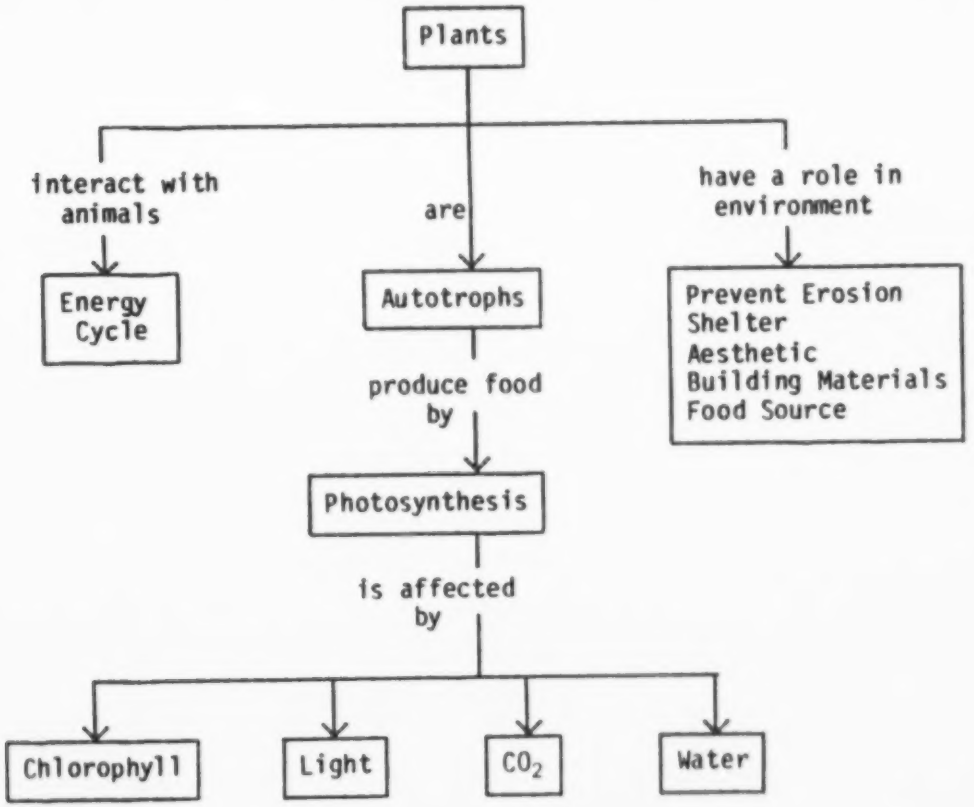
GRADE 6: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS:
INTERACTIONS OF POPULATIONS WITHIN THE ENVIRONMENT



GRADE EIGHT: CHANGES IN MATTER AND ENERGY: HEAT

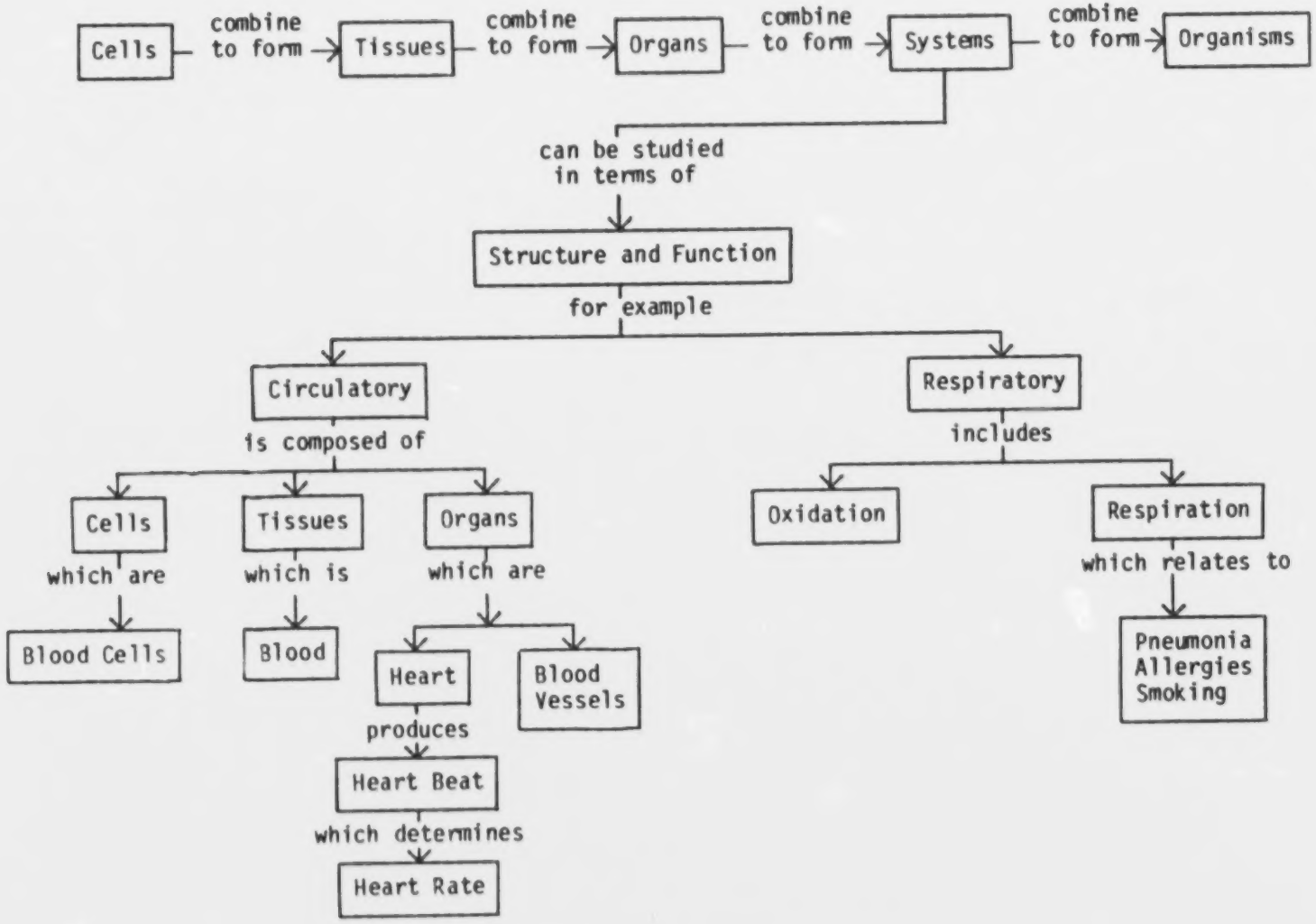


GRADE EIGHT: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: PLANTS AND THE TOTAL ENVIRONMENT

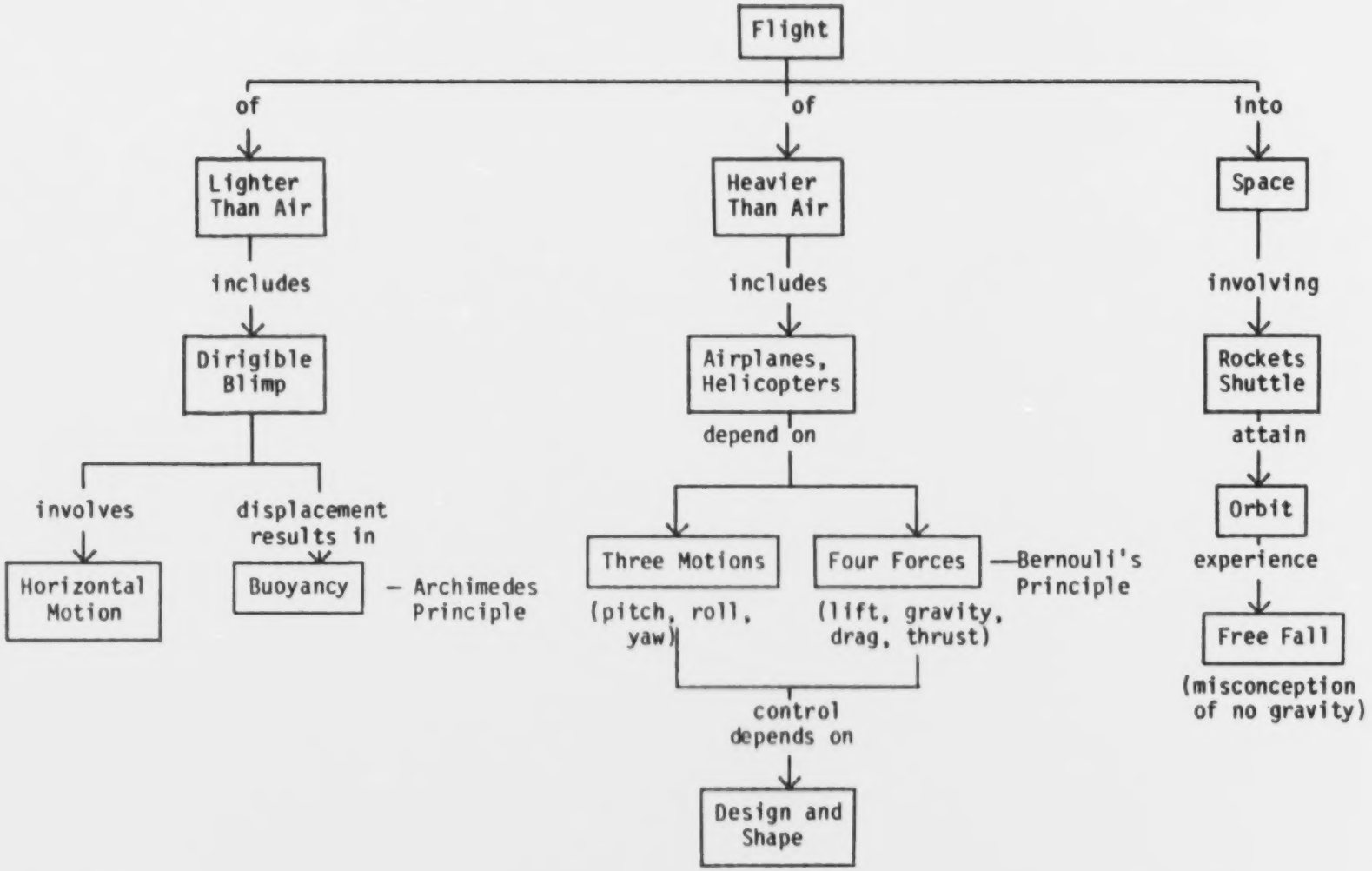


NOTE: Misconception: Soil Provides the mass of a plant.

GRADE EIGHT: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: CELLS AND ORGAN SYSTEMS



GRADE EIGHT: CHANGES IN MATTER AND ENERGY: FLIGHT



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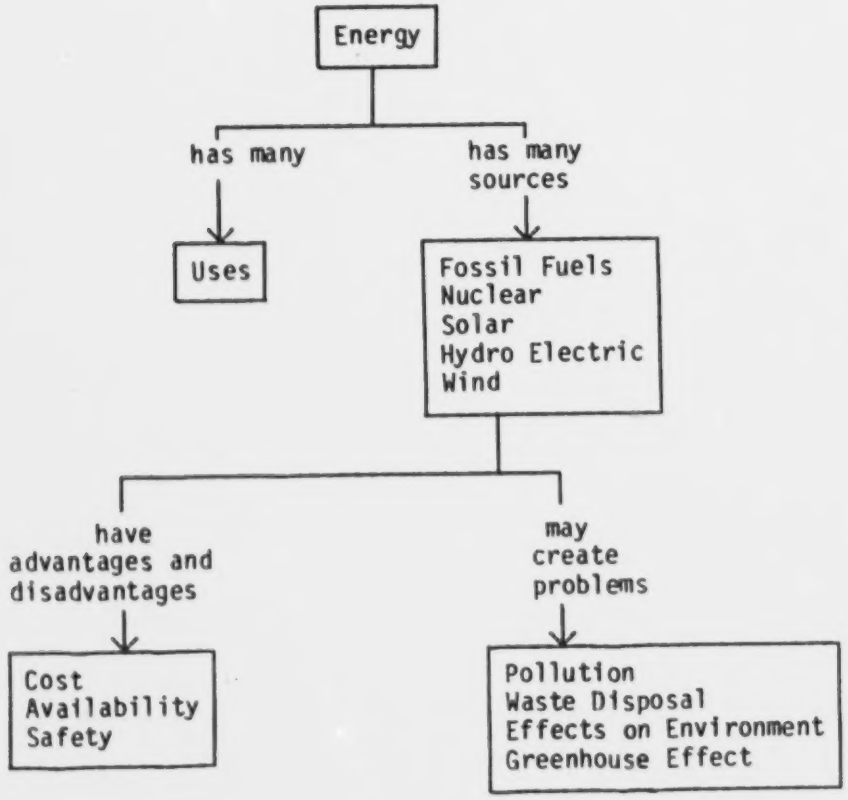
GRADE EIGHT: CHANGES IN MATTER AND ENERGY: ALTERNATIVE FORMS OF ENERGY



PROCESSES OF SCIENCE

Inquiry in science can be represented by specific intellectual skills entitled "processes." Processes are identifiable behaviours, used by scientists which can be generalized across content domains. These behaviors contribute to rational thinking in everyday affairs. In order to become an increasingly active and dynamic investigator of science the student needs to use the processes of the scientist. Through conscious, systematic development of these processes, the student will become increasingly better equipped for more complex learning in the fields of science as well as other areas of investigation.

Observing

Observing is one of the basic process skills of science. It involves obtaining information about objects, situations or events using the five senses. Observations may be qualitative or quantitative in nature. Observing provides both a basis for new inferences or hypotheses and a tool for testing existing inferences and hypotheses.

Measuring

Observations are quantified using non-standard and then standard units. Length, area, volume, mass, time intervals and force are among the measurements which are used. Appropriate measurement instruments and units within the metric system are selected. Examples of measurement include "using paper clips as standard units for measuring an object," "calibrating a scale," and "measuring the rate of hatching organisms."

Classifying

Classifying is the grouping of objects, concepts or events on the basis of some observable properties in order to show similarities, differences and/or interrelationships.

Inferring

Inferring means suggesting more about a set of conditions than is observed. Inferences are based upon observed data and past experience. This may evolve from both direct and indirect evidence and are modified on the basis of new evidence. Examples of inference include "inferring the identity of objects on the basis of observing their shadows" and "inferring the kind of material (chemical) on the basis of evidence obtained from tests."

Predicting

A forecast is made about future events on the basis of ordered data. Predictions on the basis of ordered data, extrapolation beyond an observed pattern of events, and tests of predictions can be made. Examples of prediction include "predicting the appearances of adults that will grow from young animals" and "predicting the consequences of changes in an animal habitat."

Organizing and Processing Data (Communicating)

Organizing and processing data is a process that occurs between the observation stage and the interpretation or generalization stage. It usually involves the organization of "rough" data into a more compact and meaningful way (ordering, rearranging, comparing), depicting the data pictorically or graphically, and processing data mathematically (finding slopes, tangents, etc.) in order to facilitate interpretations.

Recognizing and Identifying a Problem

This process involves recognizing and focusing on problems that can be investigated. It also includes making assumptions about possible variables and the ability to delimit (narrow down) the question under investigation in order that one can proceed to work towards a solution or the ability to formulate and express relevant questions regarding living things, objects and physical events; and general relationships.

Identifying and Controlling Variables

Identifying and controlling variables involves the process of deciding which variables or factors will influence the outcome of an experiment, situation or event, and deliberately controlling all recognized variables in a systematic manner. That is, the independent (manipulated) variable is changed in a systematic way, corresponding changes in the dependent (responding) variable are observed and measured, and all other variables are held constant (controlled). This combination of relationships is referred to as a system. Examples of systems and related variables are a pendulum system where time of a swing is affected by length of the pendulum or an index card is moved a certain distance by the impact of a marble rolling down an inclined plane.

Hypothesizing

Hypothesizing is an "educated guess" about an expected relationship between two variables in an attempt to explain a cause and effect relationship. Hypotheses are based on observations or inferences about a set of events. A hypothesis should be testable; e.g., plants require light for growth.

Designing an Experiment

Experimenting is a cause and effect test between two variables. All processes may be involved. This can begin with setting a problem to be solved, identifying the variables to be controlled, making operational definitions, devising the test to be carried out and to follow the prescribed procedure.

Interpreting Data

Interpreting is the process by which sense is made out of the observations in the form of inferences, generalizations, or explanations: the generalizations are often a relationship between the independent (manipulated) and dependent (responding) variables. It usually is a direct response to the problem under investigation and, therefore, includes judgements about the interpretation, to fit with proposed hypotheses, and the limitation of the new knowledge. The explanation or generalization thus generated adds to the student's "body of knowledge" in science.

Defining Operationally

A process whereby objects or events are defined in a way which can be observed, used, or tested; e.g., the candle is out when a puff of smoke appears, or hot meaens any temperature over 60 degrees Celsius.

Formulating Models

This process involves the use of physical or mental models while describing the behaviour of something that is unfamiliar in terms of something whose behaviour is familiar. Constant vigilance is necessary to ascertain the validity (fit) of the model or analogy with the phenomenon modeled. Models often have to be revised in order to accommodate both old and new facts.

SCIENCE PROCESSES DEVELOPMENT

SCIENCE PROCESSES	GRADE 5	6	7	8	9
1. Recognizing and Identifying a Problem					
1.1 Recognize patterns and events	D				
1.2 Delimiting and phrasing a problem	D			E	
1.3 Identifying relevant and irrelevant information	D				
2. Observing					
2.1 Use of the senses	D				
2.2 Use of tools to assist observations	D				
3. Measuring					
3.1 Use of instruments with precision	D				
3.2 Construction of simple measuring devices (scales, hygrometers)	I	D			
3.3 Verifying the accuracy of measuring devices	I				
4. Classifying					
4.1 Comparing materials or data	D				
4.2 Classifying and ordering based on a set of keys and criteria	D				
5. Inferring					
5.1 Generalizing data	D				
5.2 Determining adequacy of data as a basis for inferences	D				
5.3 Inferring relationships				I	D
6. Communicating					
6.1 Use of traditional methods (drawing, graphs)	D				
6.2 Mathematical treatment of data				I	D
6.3 Use of non-traditional or technological devices (tapes, discs, pictures)	D				

NOTE: Code - I - Introduced
D - Developed
E - Extend process - Student controlled and directed.

SCIENCE PROCESSES	GRADE 5	6	7	8	9
7. Predicting					
7.1 Identifying and testing prediction	D----------				
7.2 Predicting quantitatively based on interpolation and extrapolation	D----------				
7.3 Predicting based on application of mathematical formula					I
8. Controlling Variables					
8.1 Identify relevant variables	D----------				
8.2 Identify the control variables				I	D
9. Hypothesizing					
9.1 Evaluate existing information	D----------				
9.2 Correctly state a hypothesis	D--------	E----------			
10. Interpreting Data					
10.1 Recognize valid interpretations	D----------				
10.2 Recognize limits of interpretations (staying within the data)	D----------				
10.3 Offer alternative explanations				I	D
11. Define Operationally					
11.1 Construct simple definitions based on experiences	D----------				
11.2 Use mathematical as well as verbal definitions				I	D
12. Designing an Experiment					
12.1 Select appropriate techniques	I	D----------			
12.2 Select appropriate techniques for observation and measurement	I	D----------			
12.3 Select appropriate techniques for recording of data	I	D----------			

NOTE: Code - I - Introduced
D - Developed
E - Extend process - student controlled and directed

SCIENCE PROCESSES	GRADE	5	6	7	8	9
13. Formulating Models						
13.1 Generate spatial models		I	D----------			
13.2 Generate mathematical models						I
13.3 Critically examine models						I

Note: Code - I - Introduced
D - Developed
E - Extend process - student controlled and directed

PROBLEM SOLVING AND SCIENCE, TECHNOLOGY AND SOCIETY

To prepare a student's facility in problem solving is a goal, which is generally found among today's curricula statements. Mathematics develops skills in analyzing quantitative data and spatial relationships as tools in problem solving; social studies promotes an understanding of documental evidence and the role of values in examining social problems; and technical-vocational studies provide opportunities to solve design and practical problems. Science education, when developing scientific processes and using inquiry within a scientific context, is emphasizing a problem solving approach.

Problem solving is sometimes considered to be the solution to a word problem whereby an obvious algorithm is available to the learner e.g. a type problem. Although this interpretation of problem solving may be useful in the development and application of certain concepts, for our purposes, problem solving is defined as a process whereby a student defines and seeks a solution to a recognized problem. As such, it is more open, a process of exploration and discovery, and the development and use of skills of experimentation and testing. Although no single method exists relative to the development of problem solving skills, the following skills[6] are generally accepted in many problem solving models:

- defining the problem in a resolvable form;
- obtaining data;
- organizing data;
- analyzing data;
- generalizing and synthesizing the data;
- decision making.

[6] Good, R. and Smith, M. "How do We Make Students Better Problems Solvers": Science Teacher, April, 1987, p.p. 31-6.

This general model can be applied in a variety of situations within the science program.

The nature of science-technology and its interaction with society offers a variety of opportunities for incorporating the goal of problem solving. The following examples indicate some possibilities:

- The nature of science can be initially illustrated with younger children by using investigations with magnets or batteries and bulbs to develop process skills. With older students, the development of an understanding of the appropriateness or uncertainty of data and strategies of inquiry are an important part of problem solving.

- The nature of technology and its interaction with ourselves provides a number of opportunities for developing problem solving skills. One possibility is that of resolving problems in the consumer area such as determining the best cleaning product or fabric.[7] Designing and testing of potential technological solutions offers additional possibilities. For example, students could work with the problem of designing a simple bridge using a limited number of straws and testing its strength or constructing and testing the effectiveness of a solar cooker.[8]

[7] The University of the State of New York. Technology Education: Introduction to Technology; The State Education Department, Albany, N. Y., 1987.

[8] McGregor Ann and Scott. Bridges: A Project Book Lothrop, Lee and Shephard Books, N.Y., 1980. Householder, D.L. and Marshall J. "An Introduction to Solar Energy "Industrial Education, September 1984.

SCIENCE, TECHNOLOGY AND SOCIETY

It is useful to consider science and technology as specialized and related problem solving processes. Science is the process that may be used to attempt to answer questions and provide knowledge about the universe and living things and materials in it. Technology is the process by which products and systems are developed to satisfy recognized needs. To design and make these products or systems, the findings of science are used. A Science, Technology and Society (STS) emphasis in the science program attempts to help students understand the applications of science and how this related to the world around them, making science more relevant.

For example, the given concept might be: a technological process or device often builds on past ones, becomes obsolete or can be changed and improved. Improvement may decrease the cost of the process. The program's objective would be: the student should be able to explain why some processes become obsolete. The activity would provide the student with the means by which the objective can be achieved.

Each STS activity in the 5-9 science program has been identified with two asterisks (**) beside it. Teachers are encouraged to find or develop other examples.

SUSTAINABLE DEVELOPMENT STRATEGIES

Sustainable development is the process of maintaining our natural heritage. It is important that students are made aware of the need for judicial use and management of our natural resources. The students are the stakeholders. They need to be informed about environmental concerns and the economic devastation which occurs due to a lack of environmental protection.

A Sustainable Development Strategies (SDS) emphasis in the science program will allow students to identify the areas in which environmental damage is taking place and to explore methods by which the environment can be protected. This SDS emphasis begins in kindergarten and continues throughout the entire science curriculum.

Some units lend themselves more to SDS activities and discussions than others. Teachers are encouraged to develop and foster SDS awareness whenever the opportunity arises.

This guide identifies the SDS related objectives with three asterisks (***) beside them.

5-9 PROGRAM OBJECTIVES: SCIENCE, TECHNOLOGY AND SOCIETY

OBJECTIVES	5	6	7	8	9
Students will be able to distinguish between science and technology	X	X	X	X	X
Identify scientific principles upon which a simple technology is based	X	X	X	X	X
Identify examples of interdependence of science and technology		X	X	X	X
Identify components of a functioning technological system with inputs, outputs, feedback, control	X	X	X	X	X
Describe how technological processes or devices are related to one another	X	X	X	X	X
Explain how technology extends the abilities of human beings	X	X	X	X	X
Explain why a technological process or device becomes absolute		X	X	X	X
Demonstrate how science, technology and society interrelate		X	X	X	X
Demonstrate that technology has improved standard of living	X	X	X	X	X
List examples of the impact of technology on jobs and careers			X	X	X
Recognize that science and technology alone cannot solve society's problems			X	X	X
Demonstrate that processes and devices are developed in response to needs	X	X	X	X	X
Demonstrate that certain processes or devices are not accepted because of attitudes		X		X	X
Report on the need for funds to support R & D				X	X
Identify advances in technological processes and devices that result in nations interacting as communities				X	X
Describe probable long and short term consequences of a technological process or device		X		X	X
Accept or reject a process or device based on advantages and disadvantages		X	X	X	X
Demonstrate that several solutions may exist to technological issues			X	X	X
Cite examples in which legislation has been passed to regulate a process or device				X	X

CODE: The "X" indicates the grade level in which activities relating to each objective can be found.

OBJECTIVES	5	6	7	8	9
Identify advances in technological processes and devices that result in nations interacting as communities				X	X
Describe probable long and short term consequences of a technological process or device		X		X	X
Accept or reject a process or device based on advantages and disadvantages		X	X	X	X
Demonstrate that several solutions may exist to technological issues			X	X	X
Cite examples in which legislation has been passed to regulate a process or device				X	X

CODE: The "X" indicates the grade level in which activities relating to each objective can be found.

NOTE: Refer to Appendix "E" for information on K-9 content: S.T.S.

IMPLEMENTATION: THE PRINCIPAL'S ROLE AND PROGRAM EVALUATION

Within a school board's plans for program evaluation and implementation, the principal of a school has an important leadership role. This role includes the following activities:

- Encouraging a shared management plan of implementation for the science program by providing opportunities for cooperative planning.
- Monitoring the degree of implementation and staff needs.
- Determining the implications of the curriculum for staff training and facilities.
- Providing easy access to the materials and facilities needed for the program.

Program Design Implications

- Like the former design, the new science program is based on the assumption that a general science approach is more applicable to middle years students than a discipline-centred approach. The emphasis on the development of basic concepts and processes has been retained; however, a greater emphasis has been placed on problem solving and the relationship between science, technology and society. The program design implies that teachers of science should have a broad background in the sciences and endorse the interaction of science with the other areas of study.

- The number of units per year have been decreased from the previous program in order to enable schools to increase the emphasis upon science, technology and problem solving; however, new units such as flight, microsystems, and the changing earth's crust may require specific kinds of in-service support.

- Units such as reproduction and heredity (IX) and plant and animal interactions (IX) provide possibilities for integration with other areas of study. Provision of a plan for coordinating staff efforts would be important.

- The program is based upon the premise that schools have sufficient equipment and materials to carry out the necessary activities. Provision of necessary equipment and facilities is critical and a source of funds should be available whereby teachers can easily obtain materials locally.

- Materials will be developed and recommended to support the program. However, schools should continue to search for additional materials which may suggest different teaching emphases and offer different reading levels and student activities.

- The system of measurement used in science courses is SI. By the end of Grade 8, students should know basic SI units in length, area, volume, mass, and speed, simple conversions such as mL to L and familiarity with the newton and joule. Maintaining an emphasis upon the use of these units in the sciences, as well as related disciplines, is necessary.

Program Evaluation

Evaluating the effectiveness of the science program and cooperatively, with teachers, determining methods of achieving the important curriculum objectives is a critical role of leadership. Many sources of data and approaches can be used, such as:

- Evaluation of student achievement and analysis of the methods of evaluation.
- Determining needed teaching strategies and relative emphases upon program goals, the implications and needs for new teachers or teachers from another subject area, and general teacher preparation.
- Evaluation of the status of resource materials and facility needs.

Additional sources of information about program evaluation are:

Mechling, Kenneth R., "Taking Change: How Principals Can Improve School Science Programs," Principal January 1983, pp. 16-21; and,

Mechling, Kenneth R. and Oliver, Donna L., Promoting Science Among Principals: Handbook I-IV, National Science Teachers' Association, 1742 Connecticut Avenue, N.W., Washington, D.C., 1983.

STUDENT EVALUATION

The general purposes of student evaluation are to provide a) students with an understanding of their development and needs, b) teachers with a basis for planning necessary changes in teaching strategies and the curriculum, and c) information for parents and administrators. Evaluation should be related to program objectives and should consider a balance among science processes, manipulative and problem-solving skills, and content. Further, evaluation must be continuous and use a variety of approaches from informal observation of student activity to formal, such as achievement tests, performance (practical) items, checklists, and anecdotal records.

Some Evaluation Techniques

Informal observation techniques whereby teachers observe individual and group interactions in an activity can help to determine necessary skill development and the techniques required to improve these skills. Formal techniques include achievement (pencil and paper) tests and performance (laboratory) tests; checklists of processes, attitudes, and manipulative skills; and the examination of products such as oral presentations, reports and projects.

Partial Science Processes Checklist (5-9)

Monitoring student achievement in science processes may be helped by observing student behaviour in applying the processes. Samples of some behaviours are indicated in the following chart:

Process	Checklist of Behaviour
Measuring	Uses basic metric units as a standard; estimates, has basic concept of calibration (4-6). Uses simple measuring instruments with accuracy and precision; calibrates simple instruments; identifies appropriate standards for measuring lengths, area, volume and mass (7-9).
Classifying	Sorts objects into two sets on the basis of one property, two properties (4-6). Distinguishes between useful and relevant data, and irrelevant data; classifies a set of objects into two subsets; uses keys to identify objects and identify patterns (7-9).
Predicting	Predicts a change which is most likely to occur in a system after several observations; identifies a role for changes in a system; interpolates and extrapolates from simple graphs (4-6). Interpolates and extrapolates from more complex graphs; identifies or designs tests for predictions from data, begin to construct revisions of predictions based on additional information (7-9).

Manipulative Skills (Checklist)

Skill

- Sets up and stores apparatus safety
- Uses measuring instruments correctly
- Safe use of apparatus
  - heating
  - testing of compounds, e.g., no tasting)

Sample Performance Items

These items may be used individually or in a group (station) setting to test process and manipulative skills:

Bouncing Balls

Purpose: To test observing, measuring, interpreting and inferential skills.

Procedure: Provide students with three different balls labelled A, B and C, three different surfaces (board, rubber, carpet), metre stick and masking tape. Ask students to find out which ball will bounce best on all surface area. Ask them to record how they are going to solve the problem, record data, and justify their conclusions.

Microscope

Purpose: To test microscope skills, safety skills and observational skills.

Procedure: Ask students to identify labelled parts, to focus the microscope on coloured threads on a glass slide and identify the colour of the top thread; focus on and draw a letter "e" drawn on the slide; and focus on a cell (identify some parts).

References

Doran, R.L. Basic Measurement and Evaluation of Science Instruction. National Science Teachers' Association, 1980.

Hedges, W.D. Testing and Evaluation for the Sciences in the Secondary School. Wadsworth Publishing Company, 1966.

ADD OTHERS

CONCEPT MAPS

A concept map is a means by which the organization of subject matter is represented by a diagram. It is a two dimensional device which shows not only the concepts but the relationships among them. The relationships are represented by the words on connecting lines.

The concept map shown at the beginning of each unit will provide the teacher with a tool to plan, teach and evaluate. Each concept map serves as a model and teachers are encouraged to develop their own concept maps.

MISCONCEPTIONS IN SCIENCE

Misconceptions represent complete systems of explanations which are conceptually wrong. They are personal, in that students construct their own meanings from their own experiences. The misconceptions may seem incoherent to others, but the student doesn't see ideas as incoherent. The misconceptions are often stable; and even though new ideas are taught the old ones will remain. Some examples of misconceptions are:

1) that the mass of soil decreases as a plant is growing.

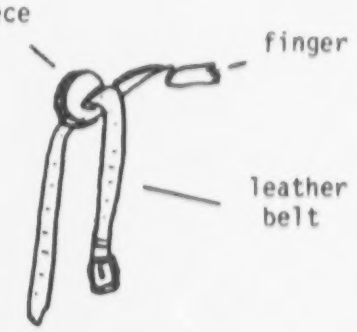
2) that molecules expand to make an object larger when it is being heated.

3) that the process of respiration is the breathing exchange of carbon dioxide and oxygen.

DISCREPANT EVENTS

A discrepant event involves a happening contrary to students' current beliefs.

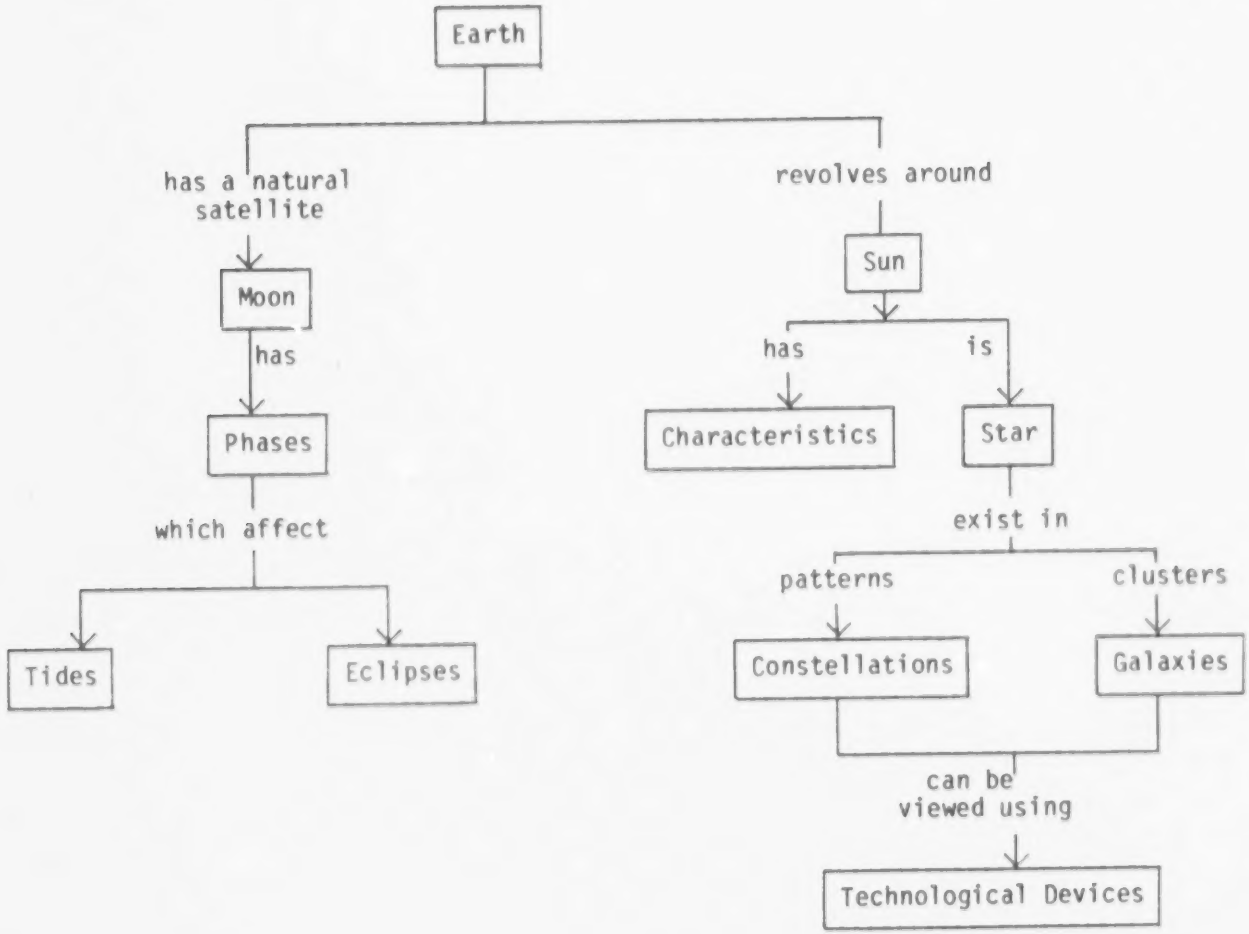
For example:



In this example, the students believe that the belt and the wooden stick cannot balance on the finger tip. This activity becomes motivational. It sparks their interest and gets students excited about science. When they see a discrepant event most students begin to wonder why and feel the need to have their questions answered.

Besides motivating students to learn scientific principles, discrepant events also provide a focus for fostering problem solving skills.

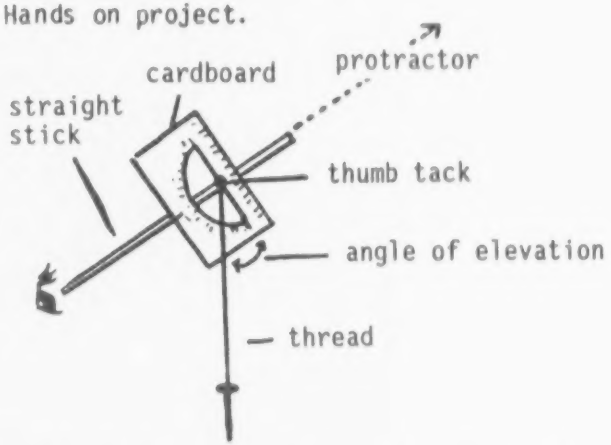
GRADE 7: EARTH, SPACE AND TIME: THE OBSERVABLE UNIVERSE



GRADE SEVEN: EARTH, SPACE AND TIME: THE OBSERVABLE UNIVERSE

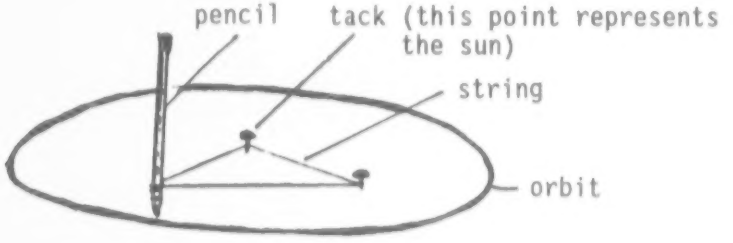
RATIONALE: This unit deals with the visible universe from our perspective on earth. We begin with our nearest neighbours, the moon and sun, and venture deep into space viewing constellations and galaxies. Technology has provided the tools to enable a viewing of space.

* Refers to Problem Solving
** Refers to STS
*** Refers to SDS

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	The student should be able to:	
1. A two coordinate system can be used to describe the location of an object in space at any given time.	a) Construct an astrolabe.	Hands on project. 
	b) Use the astrolabe to determine the position according to Azimuth and Altitude.	Demonstrate how astrolabe is used and have students practice using their models.
	c) Define Azimuth and Altitude.	Textbook Note: Altitude is equal to the angle of elevation.
	d) Plot the change in position of an object such as the moon or a star, over a period of time.	

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
2. Moon is earth's natural satellite.	a) Define satellite.	
	b) Name the common phases of the moon.	Have students study diagrams of the phases of the moon.
	c) Demonstrate phase of the moon.	
	d) Observe and record (drawings) the phases of the moon from direct observation.	Use projector and a ball.
	e) Describe the moon's orbit. (Include Apogee and perigee).	Refer to reference material.
3. Tides are produced by the gravitational effect of the moon and sun.	a) Predict how the gravities of the moon and sun are responsible for tides on Earth (include spring and neap tides).	Refer to reference material.
4. Space travel and moon visitations have provided information about the moon.	a) Describe general features of the moon.	Refer to data and information from moon exploration.
	b) Discuss the role of technology in putting a man on the moon.***	Collect information from magazines and books to emphasize that humans have indeed visited the moon.
5. An eclipse is formed when an object passes between the sun and earth (or moon).	a) Demonstrate an eclipse.	
	b) Define and identify umbra and penumbra.	

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	c) Differentiate between solar and lunar eclipses.	
6. Sun is a star.	a) Describe the sun as to: . size, . composition, . source of energy production, . layers, . sunspots.	Use current reference sources.
	b) Describe the effects of the sun on the Earth in providing solar energy.***	
7. Earth orbits the sun in an elliptical path.	a) Define aphelion, perihelion.	
	b) Construct a model of the Earth's orbit around the sun.	Use two tacks, 9 cm apart , 20 cm loop of string and a piece of paper to construct a model of an elliptical orbit.



Change the distance between the thumbtacks and observe the shape of the ellipse, try changing the length of the string.

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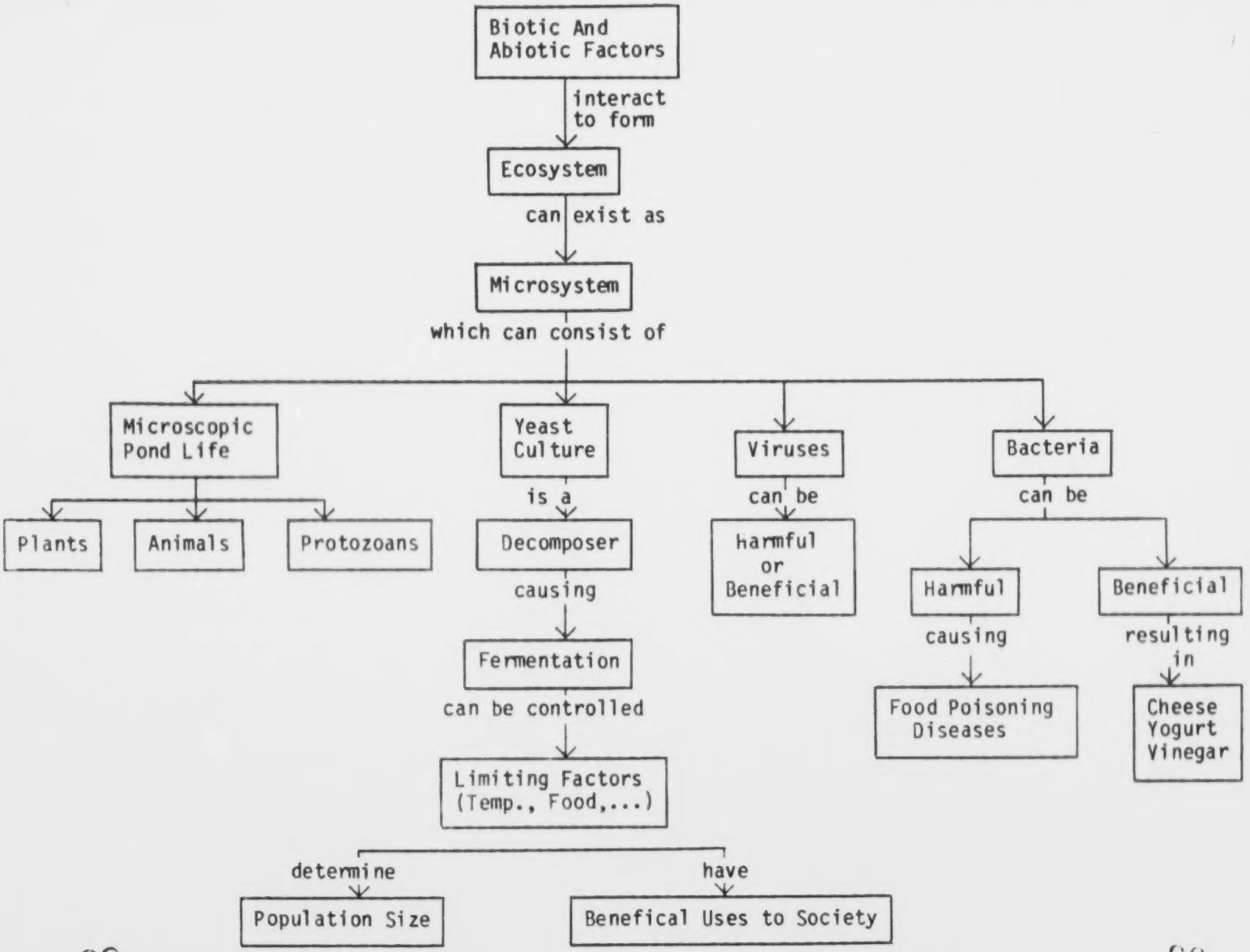
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
8. Distances between stars are immense.	a) Define the term light year.	
	b) Construct a scale diagram of the distances between the sun and neighbouring stars.	Use a suitable scale (1 mm = 1 light year). Chart the distance between the sun and near stars.
9. Stars exist in patterns called constellations.	a) Identify the coordinates of several stars using the astrolabe.	
	b) Determine the position of True North (Polaris).	
	c) Differentiate between apparent motion and real motion. (Relate apparent changes in the position of stars relative to the motion of the earth. e.g., Big Dipper circles polaris every 24 hours).	
	d) Identify the major constellations using star charts.	Obtain up-to-date star charts from Planetarium.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
10. Stars vary in brightness, colour and size.	a) Define apparent magnitude.	
	b) Describe how the colour of the star is related to temperature reflection.	Refer to up to date reference sources.
	c) Compare brightness, colour and size of other stars to our star (the sun).	
11. Stars have a life cycle.	a) Describe the stages in the life cycle.***	Refer to up-to-date reference sources. (Include nebulas, red giant, white drarf, etc.)
12. Stars exist in clusters called galaxies.	a) Observe the shape of galaxies.	Collect information and observe pictures.
13. Earth is part of the galaxy, the Milky Way.	a) Describe the position of the sun and the solar system in the Milky Way.	
14. Technology has allowed us to explore space.	a) Describe the role of the telescope in studying the universe.**	
	b) Differentiate between refractor and reflector telescopes.**	
	c) Describe features of radio telescopes and spectrascopes.**	
	e) Discuss the merits of space travel.**	Have students discuss reasons for space travel. (Include benefits and non-benefits.)

GRADE 7: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTIONS AMONG ORGANISMS: MICROBES AND ECOSYSTEMS



GRADE SEVEN: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: MICROBES AND ECOSYSTEMS

RATIONALE: An ecosystem is composed of many abiotic (non-living) factors and communities of plants and animals and Protists (biotic). Microbes are living organisms and as dependent on the environment as larger organisms. Microbes have certain limiting factors which contest their growth. Not only does the environment affect microbes, the microbes effect the environment in which they live. Microbes affect plant and animal communities beneficially as well as harmfully.

* Refers to Problem Solving
** Refers to STS
*** Refers to SDS

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
ECOSYSTEM		
	The student should be able to:	
1. An ecosystem is the interaction of biotic and abiotic factors.	a) Define ecosystem as an interaction of biotic and abiotic factors.***	Discuss biotic and abiotic relationships. Make students aware that ecosystems may be large or small.
2. Ecosystems are made up of communities of plants, animals, and protozoans.	a) State that an ecosystem is made up of communities.*** b) Describe various types of communities.*** c) Infer that communities are made up of populations.***	Note: Microorganisms found under the Kingdom Protista are called Protozoans and include amoeba, ciliates, flagellates and sporozoans.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
3. Each member within a community has a role or niche,	a) Define the terms producer, consumer and decomposer.***	Refer to several organisms which can be found.
	b) Classify organisms as being producers, consumers, decomposers.***	Include yeast.
4. Soil, air, water compose the abiotic environment.	a) Describe the non-living parts of an environment: soil, air, water.***	Discuss the role of soil, air and water as habitats in an ecosystem.
5. Elements of weather affect communities.	a) Identify and describe some elements of weather (climate) which affect ecosystems.***	Discuss the role of temperature, precipitation in terrestrial systems in an ecosystem.
MICROBES AND MICROSYSTEMS		
A microbe is a microscopic organism which cannot be seen with the unaided eye.		
1. The microscope is an essential instrument in the study of microscopic organisms.	a) Identify the parts of a microscope and describe the function of each part.	See appendix "K"
	b) Construct a wet mount slide.	Make slides of an onion cell.
	c) Focus the microscope and interpret the observations.	

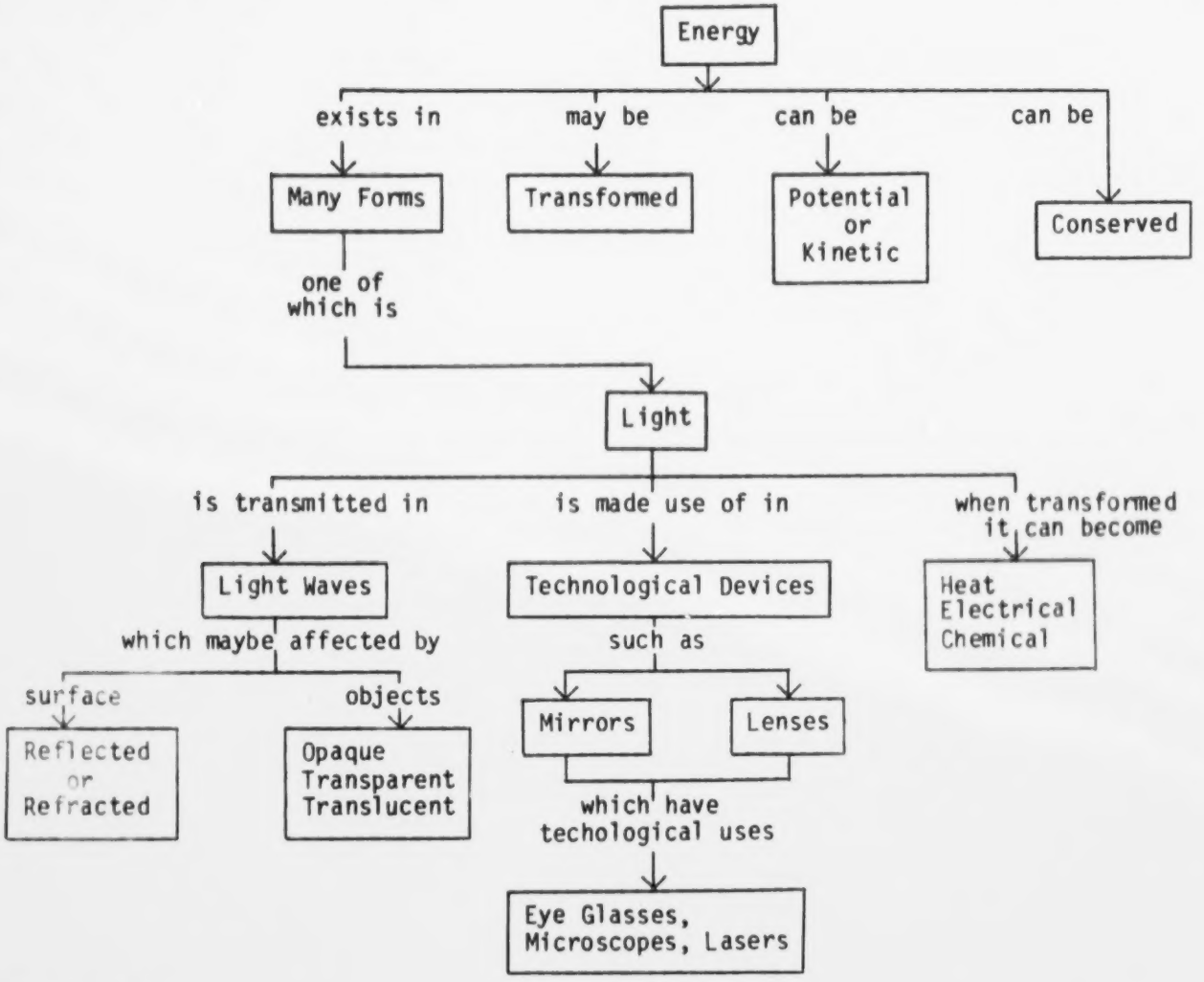
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
2. Microorganisms form a microsystem with each community having a definite role.	a) Identify microbial plant animal and protozoan communities in water.	Make slides of pond water or prepare a hay infusion and make observations with the microscope. One method of preparing a hay infusion is: Place a handful of hay (the hay can be cut into smaller pieces) and several grains of rice in a litre of water and bring to a boil. Let this stand for two days. Add 100 ml of pond water and let this stand for two more days. NOTE: If the organisms move too quickly, add a few thin strands of cotton to slow them down.
	b) Identify plants under the the microscope - aglae.	Study pond water plants under the microscope e.g. examine pond "scum" and other forms of water plants.
	c) Describe the role of plants as producers.***	Use resource books.
	d) Identify animals and protozoans under the microscope.	
	e) Describe the role of protozoams as consumers.	
3. A culture of yeast is an example of an organism in a microsystem.	a) Yeast is a living organism.	Make a sugar solution by mixing one part of corn syrup with nine parts of warm water (37°C) add a half teaspoonful of powdered yeast to the solution stir gently, cover and set aside for a couple of minutes. Prepare 250 ml. of the sugar solution and add a teaspoonful of the above yeast-syrup solution to it. Mix well. Hold the jar to the light

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		and observe the clearness of the mixture. Put a drop of the mixture on a microscope slide, add a cover sip, and make a microscopic observation. Keep the jar in a warm place for 24 hours. Note the clearness of the mixture and make another microscope observation.
	b) Define fermentation and describe the process of fermentation by yeast.	Add a teaspoon of molasses to 10 ml of warm water in a test tube. Add 1/8 of a cake of yeast and mix the contents. Attach a balloon to the mouth of the test-tube. After 30 minutes, pinch the neck of the balloon. Carefully stretch the neck of the balloon over the mouth of a test tube filled with lime water. invert the test-tube so the gas in the balloon and the limewater in the test-tube mix. Make observations.
4. Yeast is a decomposer.	a) Investigate the type of food that yeast grow on best.	Ivestigate the question: "What types of food does yeast grow on best?" Mix a package of yeast with a pint of water. Place a teaspoonful of starch into a baby food jar; a teaspoonful of white sugar into a second jar; a teaspoonful of brown sugar into a third jar; a teaspoonful of icing sugar into a fourth jar; and a teaspoonful of molasses into a fifth jar. Stir the yeast mixture and fill each jar to the brim with it. Place a cap on each jar and invert each in a shallow dish of water. There shouldn't be any bubbles of air in the jar. Place the dishes with their inverted jars in a warm

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		part of the room where they can be observed from time to time. Make observations to see which jar has the most gas at the top and which has the least. After a few hours, take measurements with a ruler to find the exact height of the ags in the jars.
5. The size and growth of a population is controlled by limiting factors such as temperature and living space.	a) Define limiting factor.***	
	b) Determine the limiting factor effect of temperature on a yeast culture.	Investigate: What effect does temperature have on the growth of a yeast population? Repeat prveious activities at different temperatures.
6. Yeast is required to cause bread to rise.	a) Observe, predict what will happen when bread is made and baked with and without yeast.	Make and bake bread with and without the use of yeast and try different varieties of yeast.
7. Viruses have harmful effects on communities.	a) Describe and state examples of viruses.	Use texts, photos, library references. Stress that viruses are sub-cellular. Contact the Department of Agriculture.
	b) Describe harmful effects of virus on plants and animals. ***	Use photos, show tobacco mosaic viral. Discuss viruses and effects on humans--cold, cancer.
8. Bacteria can be found in the ecosystem.	a) Describe and state examples of bacteria.	Describe the cellular structure of bacteria. Identify the 3 basic shapes of bacteria. Teacher demonstration: culture bacteria from fountain or doorknob swabs.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
9. Bacteria can have beneficial effects.	a) Describe beneficial effects of bacteria in nitrogen fixation, production of food production of alcohol and vinegar.**	Refer to fermentation in production of alcohol, vinegar. Refer to: production of yogurt, cottage cheese, dill pickles, tanning of leather, retting of flax. Refer to the nitrogen cycle.
10. Bacteria can have harmful effects.	a) Describe the harmful effects such as food poisoning, pneumonia, strep throat.	Refer to reference sources.
11. Food spoilage can be prevented.	a) Describe the process of pasteurization. b) Describe the role of food preservation, canning.**/***	Refer to reference sources.

GRADE 7: CHANGES IN MATTER AND ENERGY: LIGHT



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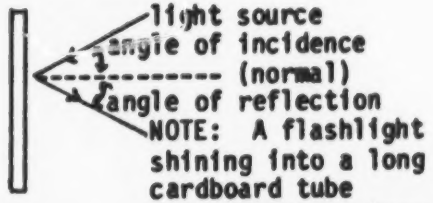
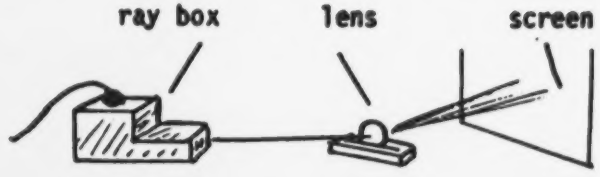
GRADE SEVEN: CHANGES IN MATTER AND ENERGY: LIGHT

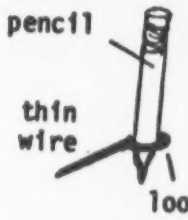
RATIONALE: Energy gives objects and humans the capacity to do work. Energy exists in many forms and may be transformed from one form to another. Light is one form of energy. Light is transformed from other sources. The students will observe the effects of the passage of light through different objects, reflection, refraction. Many technological devices depend on mirrors and lenses.

* Refers to Problem Solving
** Refers to STS
*** Refers to SDS

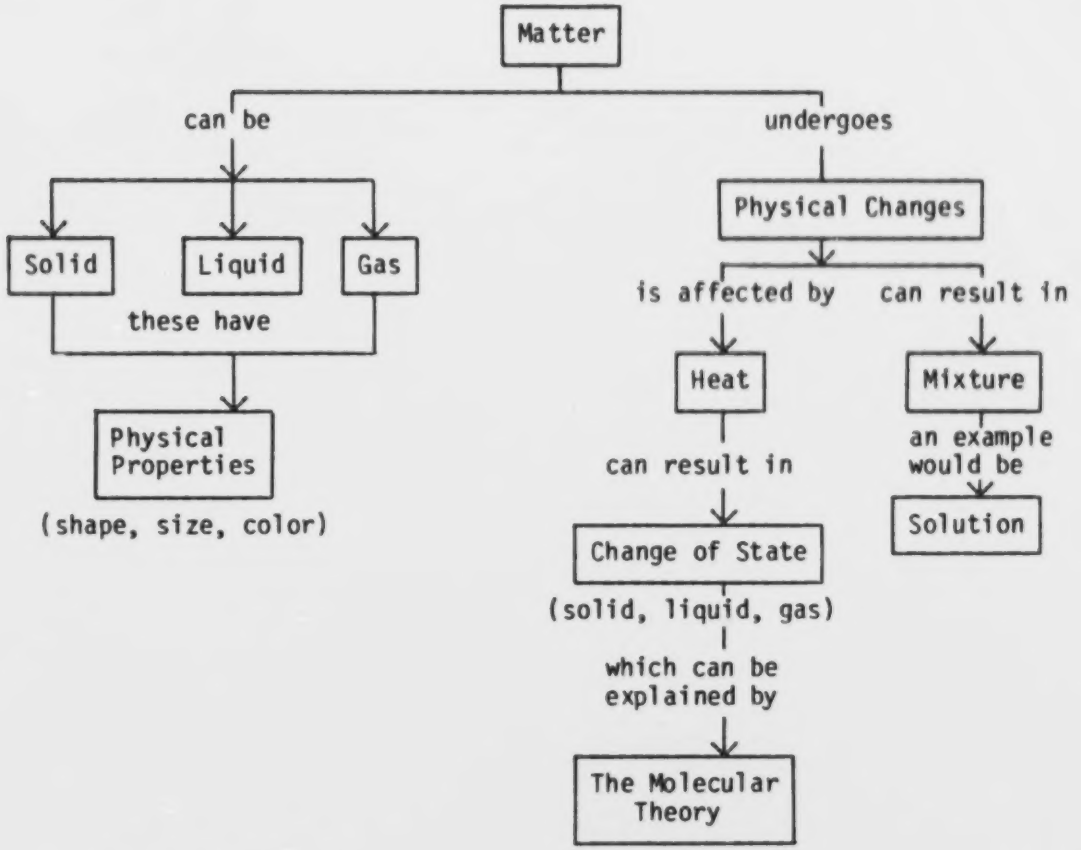
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
	The student should be able to:	
1. Energy is the ability or capacity to do work.	a) Define energy.	Class discussion. Class consensus should be that energy is the ability to do work.
2. Energy exists in many forms.	a) Identify different forms of energy.	Discussion should lead to examples such as heat, light, electrical, mechanical, chemical, solar, wind, etc.
3. Energy can be classified as potential or kinetic.	a) Distinguish between potential and kinetic energy.	Observe and describe the action of: . pendulum; . a yo-yo; . spinning rings; . Stationary and falling book. Use radiometer to illustrate that light can produce motion.
4. Energy can be conserved.	a) Describe the Law of Conservation of Energy.***	Have class discuss the law. Class consensus should be that energy can change from one to another, but it cannot be destroyed or created.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
5. Light can be transformed from heat, electricity and from chemical reaction.	a) Describe how light is transformed from heat, electricity and chemical reaction.	Discuss the transformation of chemical energy to light energy. Observe what happens when a light switch is turned on and off. Observe the striking of a match.
	b) Define the term incandescence.	Using a common light bulb, discuss how light has been produced.
	c) Define the term fluorescence.	Provide the class with pictures of neon lights. Discuss the process of light production from high levels of electricity.
	d) Define the term luminescence.	Provide picture of fire flies and glowworms.
6. Light is transmitted in waves.	a) Demonstrate the wave model.	Dip a pencil into a pan of very still water. Describe the wave motion as crests and troughs.
7. Passage of light is affected by transparent, translucent and opaque objects.	a) Identify and compare various media as to the passage of light through the media.	Pass a beam of light through clear glass, clear plastic, wax paper, a weak suspension of milk in water, black or coloured paper. Shine a light through a small aquarium filled with water. Slowly add drops of milk to the aquarium until no more light will pass through.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
8. Light is reflected from a plane surface.	a) Measure the angle of incidence and the angle of reflection.	Do activities with a light and mirror. Students can plot and measure angles of incidence and reflection on graphs (grids).  NOTE: A flashlight shining into a long cardboard tube will produce a beam of light (or film strip projector)
9. Light bends as it passes from one medium to another.	a) Demonstrate the refraction of light.	Do these activities: . pencil in water; . reappearing coin; Discuss problems created by bending of light such as spearing fish.
10. Light waves have different frequencies which form the color spectrum.	a) Demonstrate the color spectrum. b) Relate the spectrum to wave length.	Shine a flashlight unto a glass prism. Note the arrangement within the spectrum.
11. Light is refracted through convex and concave lens.	a) Compare images formed through convex and concave lens.	Do Activities with lenses. 

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
	b) Measure the focal point formed by a convex lens.	Do the water drop experiment. Slip the pencil out of the loop. Place the loop into water so that a drop is held in place. Hold the drop close to a newspaper and raise or lower it until the writing can be seen clearly. Measure the distance from the paper. 
12. Lenses have many technological applications. (Technology has increased our abilities to observe and advance scientific theories.)	a) Describe and discuss the use of lenses in:** . eye glasses; . construction and use of telescope, microscope; . lasers.	Discuss the contributions of Galileo, Leeuwenhoek.
ENRICHMENT		
1. Holograms and holography have practical applications.	a) Discuss the application of holography in detecting flaws in engines, replacement for human x-rays.**	Use up-to-date reference sources for this section.
2. Light in Communication. Transformation and trans-transfer. Technological devices can advance science and vice versa.	a) Fiber Optics.**	
3. Light can cause differences in perception.	a) Optical illusions.	

GRADE 7: CHANGES IN MATTER AND ENERGY: PHYSICAL PROPERTIES AND PHYSICAL CHANGES OF MATTER



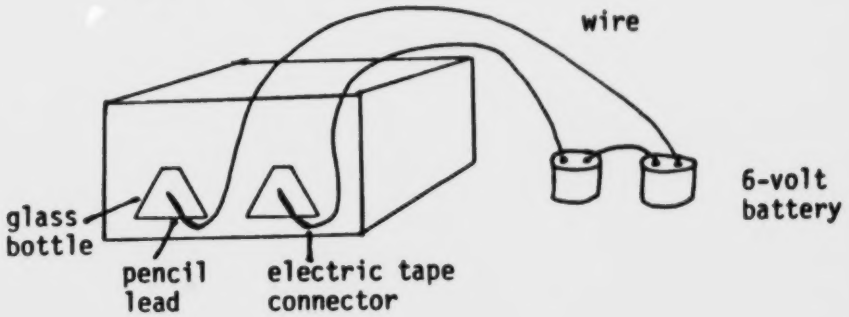
GRADE SEVEN: CHANGES IN MATTER AND ENERGY: PHYSICAL PROPERTIES AND PHYSICAL CHANGES OF MATTER

RATIONALE: The study of the physical properties of matter and physical changes which occur to matter, will help students to understand and investigate the physical world. Understanding the properties and changes of matter will enable the students to evaluate materials in daily use.

* Refers to Problem Solving
** Refers to STS
*** Refers to SDS

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	The student should be able to:	
1. Matter exists in three states with distinguishing properties. Volume, shape, mass of gas, liquid and solid.	a) Define the characteristics of solids, liquids and gases.	
	b) Measure properties of volume and mass.	Measure volume by direct and indirect means. . Use a graduated cylinder to measure volume directly. . Use a graduated cylinder half-filled with water and lower a solid into it. The difference in the two volumes is the volume measurement of the solid obtained by indirect means. Measure mass by direct and indirect means. . Place a solid sample on a balance and record the reading. . Place an empty beaker on a balance and record the reading. Half fill the beaker with water and place it on the balance. Record the reading. The difference in the two readings is the mass of the water. Use a suitable reference source.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
2. The Molecular Theory can be used to explain physical properties of matter.	a) State the Molecular Theory.	
	b) Provide evidence to support the molecular theory.	
	. Matter is made up of molecules.	Separate water into molecules of hydrogen and oxygen.



Bubbles will rise and collect in each glass bottle. When the first bottle is filled with gas, cover the mouth with your fingers and remove it. Place a glowing wood splinter near the mouth. If there is a tiny "pop," the gas is hydrogen. If the splinter bursts into flames, the gas is oxygen.

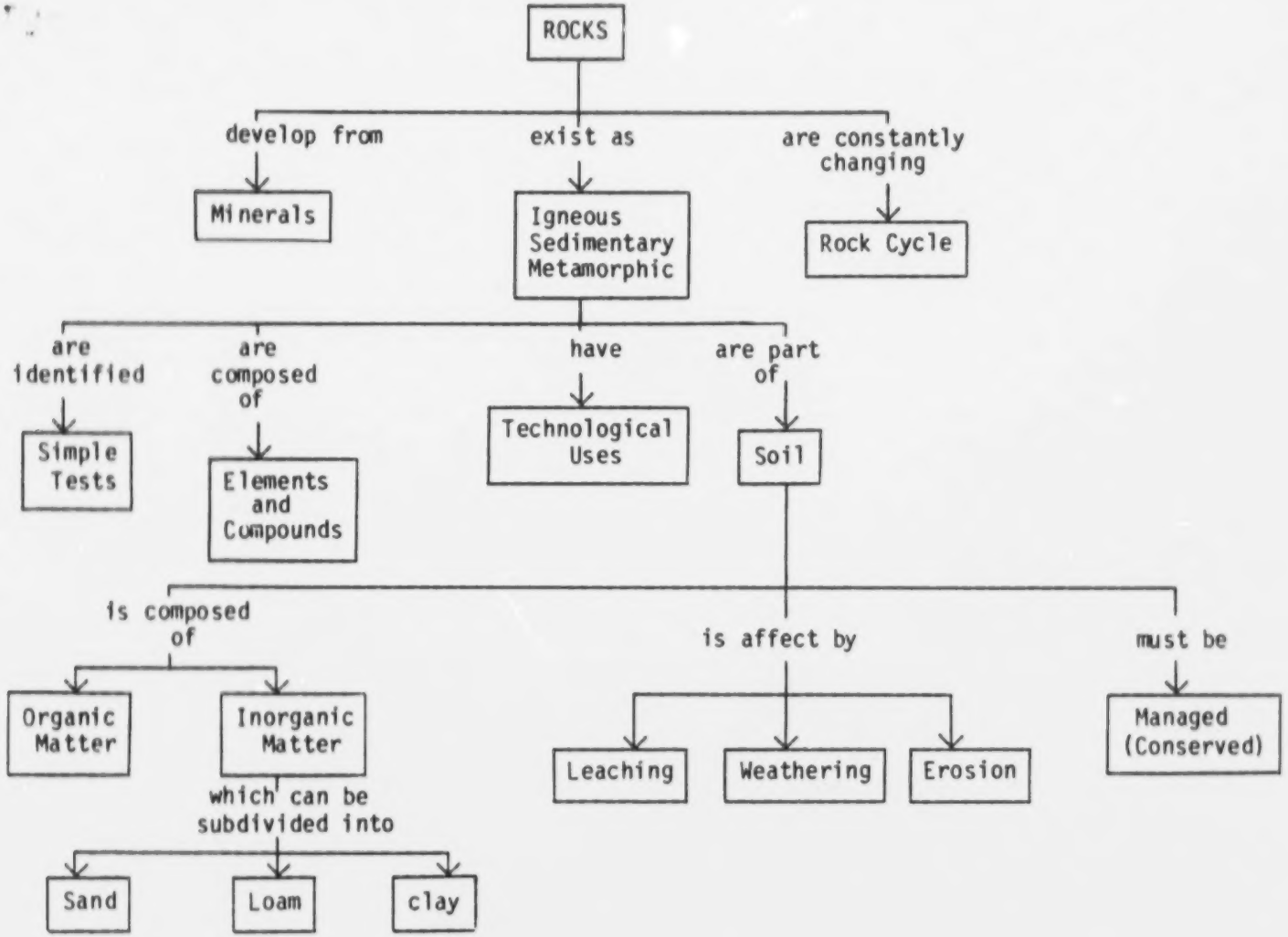
. There are spaces between the molecules.	Put equal, measured volumes of water and alcohol into a graduated cylinder. Gently agitate the mixture and observe the combined volume.
. Molecules are constantly moving.	Place a drop of food colouring into a glass of water and note how it spreads throughout the glass. Note also that this is an example of diffusion.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	. Heat speeds up the motion of molecules.	Repeat the above activity, add heat and observe the movement.
	c) Apply the Molecular Theory to explain the states of matter (solid, liquid, and gas).	Have students determine how the molecular theory can be used to explain the 3 states of matter.
3. Changes in state occur when heat is added or removed.	a) Name and define the processes, in terms of heat requirements, by which matter changes states: - evaporation; - condensation; - meeting; - freezing; - sublimation.	Distill some colored water (muddy water). Possible demonstrations: . Demonstrate sublimation using iodine crystals. As an alternative demonstration use dry ice if it is available. Discussion can include frost formation, snow crystal development, moth crystal disappearance.
	b) Compare the rates of evaporation of water at different temperatures.	Use 3 beakers or containers of same size. Place equal volumes of water in each container. Put one in the refrigerator, one on a hot plate and the last one on a cupboard. Observe the water loss.
	c) Compare the rates of evaporation of different liquids.	Use rubbing alcohol and water and record the time required to evaporate each over low heat. Use a suitable reference source.
Heat of Fusion and Heat of Vaporization naturally occur during a change of state. The temperature is unchanged during a phase change.	d) Define terms Heat of Fusion and Heat of Vaporization.	Graph the temperature change and time requirements when water changes states (ice to water to vapour). Label the location of heat of fusion and heat of vaporization on the graphs. (Hint: Use ice water mixture.)

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
The temperature is unchanged during a change of state.	e) Define and measure boiling point and melting point.	Test different materials relative to boiling point and melting point. Design a simple water still which could be used on sea water.
Adding substances to water will change the freezing point and boiling point.	f) Test the effect of adding substances (salt, sugar) on freezing point and boiling point of water.	Add salt or sugar to water and check freezing point and boiling point. Test the temperature when freezing water in a container surrounded by ice-salt layers. Discuss - the making of ice-cream; - addition of salt to streets; - addition of antifreeze to radiators.
In nature, the water cycle results when heat is added or removed.	g) Apply the concepts from changes of state to the water cycle.**	Refer to pictures of the water cycle. **Design a technological device to obtain water from the atmosphere.
4. Formation of a mixture is a physical change.	a) Define mixture.	Demonstrate several mixtures involving two solids (salt and pepper), and and water, sugar and water.
	b) Describe and investigate the separation of the components of mixtures.	Have students devise methods of separating mixtures such as iron fillings and salt; sand & salt. Methods could be: . using a magnet . filtration . sedimentation . straining . distillation . evaporation

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
5. Substances can dissolve in water.	a) Define solute, solvent, solution, unsaturated solution, saturated solution and supersaturated solution.	Use reference sources.
	b) Identify factors or variables which affect the rate of dissolving substances.	Test different solutes in water. Have students identify factors or variables which might enable a solution to be formed. (Change solvent, put in powder form.)
	c) Describe how a solution is formed using the molecular theory.	
6. Industrial products utilize certain physical properties of substances to provide effects which may improve our lives.	a) Design and conduct experiments to test properties of various substances.	Test products such as: . drink powders for solubility; . paper towels for absorbency.
	b) Establish criteria and controls to evaluate results of the tests.	
7. Basic physical properties are fundamental to new technology.	a) Describe how new devices have developed as technology improves.	Examine devices to determine how advancing technology has improved them, e.g., eye glasses.

GRADE 7: EARTH, SPACE, AND TIME: ROCKS, MINERALS AND SOIL



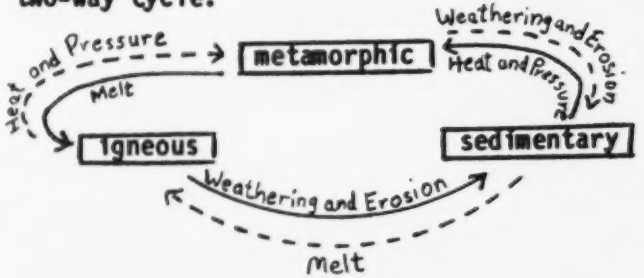
GRADE SEVEN: EARTH, SPACE, AND TIME: ROCKS, MINERALS AND SOILS

RATIONALE: Rocks are the solid matter which make up the earth's crust. Students will examine the different methods by which rocks have been formed. The mineral component of this unit allows for many hands-on tests to identify the minerals found in or which make up the rocks. Soil is essential for the growth of plants. Students will examine the composition of soil. Our soils must be managed if there is to be adequate soil for future generations.

* Refers to Problem Solving
** Refers to STS
*** Refers to SDS

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
ROCKS AND MINERALS		
	The student should be able to:	
1. A rock is the solid matter constituting the Earth's crust.	a) Define the term rock.	Class discussion:
2. Igneous rocks are formed from molten lava.	a) Develop the model of igneous rock formation by using simple and complex melts.	Hold a burning candle so that the wax drips on to an aluminum plate. This is a melt. Have students suggest ways of speeding up or slowing down the process. Repeat the burning candle activities and melt some shortening. Observe the characteristics of both melts and then mix them together. Discuss the new observations.
	b) Distinguish between extrusive (volcanic) and intrusive (plutonic) igneous rocks.	Pictures and discussion. Extrusive rocks form when magma is exposed at the earth's surface as lava and then cools and hardens. Intrusive rocks form as magma is forced into rocks and spaces between rock layers and then slowly cools.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
		Igneous: Intrusive — Granite, Diorite, Gabbro; Extrusive — Rhyolite, Andesite, Basalt
3. Sedimentary rocks are formed in layers. Metamorphic and igneous can be layered.	a) Predict the order in which sediments are deposited.	Do activities with sediments and observe the settling of sediments.
	b) Develop a model to show rate of sedimentation.	
	c) Describe the formation of rocks by sedimentation.	Make a sedimentary rock using sand and alum. Use a paper cup. Produce a concentrated alum solution, mix with sand and let stand until dry. Peel away the paper cup. Epsom salts may be used in place of alum.
	d) Classify sandstone, shale, coral reefs as being sedimentary.	
4. Metamorphic rocks result from rocks which have changed due to heat and pressure.	a) Describe how heat and pressure have created metamorphic rocks.	Class discussion. Identify marble and slate as examples of metamorphic rocks.
	b) Develop a model to show how metamorphic rocks are formed.	Do the activity that answers the question: "How does time and weight affect layers of sediments?" Develop the concept that metamorphic rocks are hardest and densest.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
		Do the activity of arranging a set of rocks into the correct classification.
5. Rocks are continuously changing and this change is called the rock cycle.	a) Describe the rock cycle.	Use diagrams. Note that the cycle can be a two-way cycle. 
6. Minerals are naturally occurring solid elements and compounds which can be identified by simple tests.	a) Define minerals, elements, and compounds.	Use reference books and pictures.
	b) Examine and test a variety of minerals for hardness, streak, cleavage, fracture, colour, flame test color, lustre, and specific gravity.	Obtain minerals from Department of Mines or other sources, examine and carry out the tests.
	c) Identify mineral specimens according to their characteristic properties.	Give the students a sample of minerals and have them identify each.
7. Rocks and minerals have many uses.	a) Describe uses of minerals: - making Plaster of Paris; - diamond drilling; - limestone in construction. **	

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
SOIL AND SOIL MANAGEMENT		
8. Soil is the uppermost layer of the earth's surface.	a) Describe the layers of a soil profile.	Use pictures: discuss topsoil, subsoil and bed rock.
	b) Infer why soil profiles differ in different locales.	Observe a section of soil profile in a ditch, quarry, excavation, etc.
9. Soil is a mixture of organic and mineral material plus water and air.	a) Identify the soil components: . organic or humus, . mineral, . air, . water.	Have each student bring a small amount of soil. Place the sample in a petri dish. Use a straight pin and separate the particles. Record observations. Note that organic matter is in various stages of decay. Note that there are spaces. Between the particles which can contain air and water. Examine minute particles under a microscope. Place a small amount of the original sample in a test tube. Hold it at an angle over a heat source and observe the top inner surface of the tube.
	b) Determine the approximate percentage of each component from a circle graph.	Present the students with a circle graph and determine the percentage of each component present in the sample.
10. Soil is constantly changing and being formed by addition, leaching, weathering and erosion.	a) Describe the process by which humus is returned to the soil.	In fall or spring, bring in samples of decaying plant material and examine them for various stages of decay.
	b) Discuss the advantage of adding humus to the soil.	
	c) Observe and describe the translocation of minerals by leaching.	Place filter paper inside a funnel. Put peat moss; sand; soil into the filter paper and pour water (measured amount - 300 ml.) into the funnel. Collect the leachate. Observe the leachate for color change.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
11. Size and mass of particles effect the deposition of soil by wind erosion.	a) Discuss the effect of wind and water on weathering.	Have students develop a simple wind tunnel and water table. Set up activities with each apparatus which will lead to evidence of erosion. Observe the effects of wind and water erosion.
12. Soils are identified as being sand, loam or clay.	a) Identify soil as being sand, loam or clay based on particle size and/or texture.	Examine soil samples and compare them.
13. Soil and the environment determine the vegetation.	a) Discuss the interaction of soil and climate on vegetation.***	Note: Cross-over with social studies.
	b) Describe the conditions that exist in the prairie grasslands.	Relate the vegetation in the prairie grasslands to availability of moisture; fluctuating temperature; winds, etc.
14. Soil must be managed.	a) Discuss the need to fertilize.***	Obtain information from Agriculture Manitoba, the Faculty of Agriculture, or the University of Manitoba, local agricultural reps, fertilizer companies, etc. Include the positive and negative effects of the use of fertilizers.
15. Soil must be conserved.	a) Describe methods of preventing erosion.**/***	Use information supplied by the above source.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
ENRICHMENT		
1. Crystals.	a) Grow and describe the general shapes of crystals. b) Identify variables which affect size of crystals.	Slowly add 60 grams of alum to 1125 mL of water. Heat the mixture while stirring it until all of the alum has dissolved. When the hot water holds all the alum it can in solution, the solution is super saturated. Pour the liquid into a small jar. Hang a small paper clip by a thread in the jar. (Make certain that the clip is submerged.) Cover the jar. Place the jar in a spot where it will cool slowly and can be observed at regular intervals. Repeat this activity using Epsom salts, Rochelle salt, and copper sulphate.

APPENDIX "A"

GENERAL PROGRAM OVERVIEW K-4

THEMES	K	1	2	3	4
ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS	LIVING AND NON-LIVING	ANIMALS AS LIVING ORGANISMS PEOPLE ARE LIVING ORGANISMS	LIVING ORGANISMS IN THE ENVIRONMENT	LIFE CYCLES	POPULATION INTERACTIONS
CHANGES IN MATTER AND ENERGY	PROPERTIES OF OBJECTS	PROPERTIES OF MATTER	FLOTATION: A PROPERTY: OR MATTER	CHANGES IN MATTER ENERGY, HEAT AND TEMPERATURES AIR AND AIR PRESSURE	ELECTRICITY SOUND STRUCTURES
EARTH, SPACE AND TIME	SIZE, POSITION AND TIME	COMPARING AND MEASURING EVENTS	MEASURING TIME, OBJECTS AND POSITION LIGHT AND SHADOWS	THE EARTH, SUN AND MOON	WATER AND LAND

5	6	7	8	9
ADAPTATIONS TO ENVIRONMENT	INTERACTIONS OF POPULATIONS WITH ENVIRONMENT	MICROBES AND ECOSYTEMS	CELLS AND ORGAN SYSTEMS --- PLANTS AND THE ENVIRONMENT	REPRODUCTION AND HEREDITY --- PLANT AND ANIMAL INTERACTIONS
ELECTRIC CHARGES --- FORCE AND MOTION --- PHYSICAL AND CHEMICAL CHANGE	FORCE AND MOTION --- SIMPLE MACHINES	LIGHT --- PHYSICAL PROPERTIES AND PHYSICAL CHANGES OF MATTER	HEAT --- ALTERNATIVE FORMS OF ENERGY --- FLIGHT	FORCE, WORK AND MOTION --- CHEMICAL INTERACTIONS
THE CHANGING EARTH	WEATHER --- THE EARTH IN SPACE	ROCKS, MINERALS AND SOILS --- THE OBSERVABLE UNIVERSE		CHANGING EARTH'S CRUST

APPENDIX "B" **SCIENCE PROCESSES DEVELOPMENT: K-9**

PROCESSES	K-3	4-6	7-9
1.0 Observing			
1.1 Identity and state properties and changes in an object using senses	ID	D	E
and events	ID	E	E
1.3 Identify and describe elements of a system, motion of an object relative to a reference point	I	D	E
1.4 Distinguish between qualitative and quantitative observations		ID	E
1.5 Distinguish between observation and inference		I	DE
2.0 Measuring			
2.1 Select and use appropriate instruments with precision. Use SI	I	ID	ID
2.2 Design and construct simple measuring devices (measuring time, scales, hygrometers)		I	I
2.3 Calculate the efficiency of simple machines			ID
3.0 Classifying			
3.1 Distinguish between objective and subjective information, fact and inference			ID
3.2 Sort objects into groups according to similarities and differences and/or quantitative measurements	I	ID	DE
3.3 Develop classification systems	I	I	ID
3.4 Use a dichotomous key			I

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E - Extend process (student controlled and directed).

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SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
4.0 Inferring			
4.1 Identify observations which support an inference	I	ID	DE
4.2 Describe additional observations needed to test alternative inferences	I	ID	DE
4.3 Identify inferences that should be accepted, rejected or modified on the basis of additional observations		ID	DE
5.0 Communicating			
5.1 Describe and sequence a series of events orally or in writing	ID	DE	E
5.2 Construct a simple data table or graph	I	DE	E
5.3 Construct a line graph and represent principles using a mathematical format		ID	D
5.4 Write an accurate report describing events		I	D
6.0 Predicting			
6.1 Make and confirm simple predictions using an activity	ID	E	E
6.2 Predict the consequences of removing or altering one or more system-components		ID	DE
6.3 Interpolate and extrapolate from patterns or graphs; predict from formulae		I	D
6.4 Design tests for predictions; maintain, remove, or modify predictions		I	DE

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SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
7.0 Interpreting Data			
7.1 Distinguish between relevant and irrelevant data using observation, reading, or listening	I	ID	DE
7.2 Recognize limits of data, biases and their distortions		I	D
7.3 Interpret cause and effect relationship within a problem solving situation, construct inferences from data		I	D
8.0 Recognizing and Identify a Problem			
8.1 Recognize patterns and events	I	D	D
8.2 Delimiting and phrasing a problem		ID	DE
9.0 Controlling Variables			
9.1 Identify relevant variables manipulated and responding to test a given hypothesis		ID	DE
9.2 Examine collected data and select relevant data		I	D
9.3 Identify variables (manipulated and responding from observations)			ID
10.0 Hypothesizing			
10.1 Distinguish between a) opinion and hypotheses		I	D
b) hypotheses, theory and Taw			ID
c) inferences and hypotheses			D
10.2 Identify a testable hypothesis and revise when indicated by data		I	DE

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SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
11.0 Operational Definitions			
11.1 Construct definitions on the basis of changes which occur or what an object does or how it is used		ID	DE
11.2 Contrast an operational definition with a non-operational definition		I	DE
11.3 Construct operational definitions		I	DE
12.0 Designing an Experiment			
12.1 Recognize the manipulated and responding variables			ID
12.2 Design, conduct and report an experiment using appropriate techniques			DE
13.0 Formulating Models			
13.1 Identify similarities and differences in the models of two systems		ID	D
13.2 Generate spatial models		ID	E
13.3 Generate mathematical models			ID

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APPENDIX "C" **SCIENCE PROCESSES DEVELOPMENT - PROBLEM SOLVING: K-9**

PROBLEM SOLVING	K-3	4-6	7-9
1.0 Apply appropriate questions when a problem is stated	I	ID	E
2.0 Transform information into a representation illustrating a solution		I	DE
3.0 Recognizing alternative factors affecting possible solutions and propose strategies for solution		I	D
4.0 Establish criteria for judging a solution		ID	E
5.0 Collect, analyze and synthesize relevant information		ID	DE
6.0 Identify alternate models or drawings to illustrate a solution to a problem		I	D
7.0 Recognize, and define a problem in a researchable format			ID

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APPENDIX "D"

OBJECTIVES AND CONCEPTS FOR SCIENCE-TECHNOLOGY AND SOCIETAL INTERACTIONS

CONCEPTS	PROGRAM OBJECTIVES
SCIENCE AND TECHNOLOGY	
- Science is the process of increasing and testing our knowledge of the natural world; enables us to predict the outcome of events in the natural world. - Technology is the process of using resources and scientific knowledge to develop products and/or processes which attempt to resolve problems and/or needs of society. - Science and technology advance one another. Technological processes are sometimes invented without knowledge of the scientific principle behind them.	The student will be able to: - Distinguish between science and technology. - Identify the principle(s) upon which simple technologies are based. - Identify examples of interdependence between science and technology.
NATURE OF TECHNOLOGY	
- Some technolgical devices and processes can be viewed as systems, or a series of simpler devices working as a system. - Technological processes and devices extend the abilities of humans and affect the environment. - A technological process or device often builds on past ones, becomes obsolete or can be changed and improved. Improvement may decrease the cost of the process.	- Identify the components of a functioning technological system including input, output, feedback and control. - Describe ways technological processes are related and extends the abilities of humans. - Explain why some processes become obsolete.

CONCEPTS	OBJECTIVES
INTERACTION OF SCIENCE, TECHNOLOGY AND SOCIETY	
- Changes in either science-technology or society has often affected the other.	- Demonstrate how science, technology and society are interrelated, it has improved the standard of living, imparted jobs and careers.
- Refinements in processes has resulted in new products to change lifestyles and industry.	- Describe that science and technology alone cannot solve society's problem.
- New industries may be created and others become obsolete, affect career choices, employment and education needs.	- Demonstrate that a technological process or device may be developed due to individual or societal needs and may be accepted or rejected because of societal attitudes.
- A technological process or device is usually developed in response to needs; however, sometimes the device is developed and the need created by marketing.	- Identify how technological advances have affected the interactions of nations.
- Technological advances have had global impacts.	
MAKING DECISIONS	
- Technological processes and devices offer increased choices. The purpose of a process and the choice made for its use determines its impact on society.	- Describe probable long and short-term consequences of a technological process or device.
- Decisions should be based on long and short-term consequences. Resolution of complex issues requires data from experts in many disciplines. Experts often disagree about solutions.	- To assess and accept or reject a particular technological process or device based on its advantages and disadvantages.
- Trade offs are sometimes made between the advantages and disadvantages for people and the environment. Some burdens are accepted because benefits outweigh them.	- Demonstrate some alternative solutions to technological issues.

CONCEPTS	OBJECTIVES
- A decision about a technological process or device leads to other questions and issues. Resolution of an issue may not be acceptable to all persons and groups.	
- Governments sometimes pass laws to regulate and control use of a technological process e.g. seat belts, nuclear power. Growth of science and technology is affected by public funding decisions.	Cite examples of legislation which has been passed to regulate a technological device.

APPENDIX "E" K-9 SCIENCE, TECHNOLOGY AND SOCIETY CONTENT

OBJECTIVES	K-3	4-6	7-9
Students will be able to:			
SCIENCE AND TECHNOLOGY DEFINED			
Distinguish between science and technology		I	D
Identify scientific principles upon which a simple technology is based		I	D
Identify examples of interdependence of science and technology			ID
Identify components of a functioning technological system with inputs, outputs, feedback, control		I	D
NATURE OF TECHNOLOGY			
Describe how technological processes or devices are related to one another		I	D
Explain how technology extends the abilities of human beings and affect the environment	I	D	D
Explain how and why a technological process or device becomes obsolete or is modified		I	D
Demonstrate how science, technology and science interrelate, has affected living standards and imparted on jobs or careers			ID
INTERACTION WITH SOCIETY			
Recognize that science and technology alone cannot solve society's problems			ID
Demonstrate that processes and devices are sometimes developed in response to needs	I	D	D
Demonstrate that certain processes or devices are not accepted because of societal attitudes			
Identify advances in technological processes and devices that result in nations interacting as communities such as acid rain, satellite television			ID
DECISIONS			
Describe probable long and short term consequences of a technological process or device - increased choices, advantages and disadvantages			ID
Assess a process or device based on short and long-term consequences			ID
Demonstrate that several solutions may exist to technolgical issues			ID
Cite examples in which legislation has been passed to regulate a process or device			

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APPENDIX "E"

USES OF COMPUTERS IN SCIENCE

1. Tools
2. Experimentation
3. Simulation
4. Computer Assisted Learning (CAL)

Definitions

Tools - software which assists teachers or students to manipulate or manage information. Examples include word processors, databases, spreadsheets, graphics-generation software, and teacher utilities.

Experimentation - computer hardware and/or software used for the collection and preparation of data for analysis. Using hardware input devices, measurements such as temperature, light intensity, PH, electric current, and time could be gathered directly by the computer.

Simulation - courseware which imitates a system (ecology, astronomy), a process, training (balances, oscilloscope, titration), or an experiment (for reasons of cost, hazard, duration, etc.), or courseware which provides abstract simulations from, say, chemistry or physics.

Computer Assisted Learning (CAL) - courseware whose main purpose is either to teach concepts or skills (tutorials) or for drill and practice.

Problem solving and the problem-solving process are acknowledged as an integral part of K-9 science and as such they are not identified separately in this discussion.

Computers are not a substitute for a well-balanced science program. However, computer courseware can enrich the science curriculum and if the courseware has been well developed it can help to make science instruction more effective. Teachers are encouraged to evaluate available courseware to determine its effectiveness prior to making a purchase.

APPENDIX "G"

SAFETY IN SCIENCE

The science program has been designed to stimulate interest in the students by performing many hands-on activities. Positive attitudes towards safety and the proper use of laboratory equipment must be developed in the students. The major causes of accidents are negative attitudes towards safety and carelessness.

Although the majority of the topics and activities are relatively safe, the onus is on the administration and the teacher to ensure safe laboratory experiences. A safe laboratory must have safety equipment and safety instruction as to the use of the equipment.

A complete list and description of safety equipment and safety procedures may be found in Safety in Science, Curriculum Support Series. The manual is available through Manitoba Education.

WOMEN IN SCIENCE

The role of the female in science has not kept pace with the expanding effect of science and technology on society. A concerted effort is needed by all educators to change the attitude of early adolescent females towards science and their roles in the scientific community. Educators must make a conscious effort to eliminate the unconscious bias that exists in classrooms towards women in science.

Guidelines for Addressing Sexual Bias in Classrooms

Teachers can:

. use inclusive, rather than exclusive, language.

. assure that textbooks, reference materials, films, videos, visual displays give equal consideration to both sexes in career and lifestyle portrayals.

. be aware that habit and tradition may result in different teacher expectations for girls than for boys and that the students own expectations may be reflected in their success rates. Both expectations may be communicated subtlety and may, therefore, be difficult to detect and correct.

. be aware that studies have shown that boys receive considerably more teacher feedback, occupy more physical space, are more critical of girls and of each other, and generally assume the leadership role in a mixed group. This has implications for almost every aspect of classroom management and methodology.

. question not just the content of a curriculum, which often ignores or gives little attention to women's contributions, but the context and definition of success or knowledge, which often predeterminines that what is seen as male and what is seen as a contribution are synonyomous.

. encourage projects which recognize skills and interests of both sexes and discourage put-downers or devaluing of "female" interests--by male students.

APPENDIX "H"

SCIENCE FAIRS

A science fair is an exhibition of innovative activities, hands-on experiments and/or scientific research or literature reviews. The most important feature of the science fair is the work of each individual student. The fair is a method or mechanism to display the creative work of the student.

Some of the benefits of carrying out a science fair project include:

- the chance to express creativity and initiative in independent research;
- the experience of the excitement and frustration of scientific research;
- the opportunity to develop special skills in written communication, oral presentation and organization of work.

The work on a science fair project may be divided into three stages.

1. Preliminary planning and choosing of a topic.
2. Research or experimentation. Keep a daily log book.
3. Science fair project--the blackboard and display.

There are excellent publications, Science Fair Project Ideas, The Science Fair Rookie Kit and Handbook of Helpful Hints for Elementary Science Fairs, which are available to interested teachers. Refer to the annotations.

ANNOTATIONS

1. Science Fair Project Ideas--Youth Science Foundation, Suite 805, 151 Slater Street, Ottawa K1P 5H3.

2. The Science Fair Rookie Kit. MSSS. (Available through Manitoba Education and Training.)

3. Handbook of Helpful Hints for Elementary Science--T. Bilyk. (Available through Manitoba Education and Training.)

APPENDIX "I"

BASIC EQUIPMENT LIST

Grades 5 and 6

bar magnet
steel balls
paper clips
metre sticks
washers (different sizes)
spring balance (optional)
plastic pails
balloons
thread
string
paraffin wax
zinc sheets
copper
vinegar
lemon juice
compass
copper wire
steel wire
dry cell
6 volt batteries

sugar
sand
hand lens
microscope
modelling clay
candles
food colouring
bromthymal blue
alka seltzer tablets
yeast
rock samples
plaster of Paris
containers
birdseed
seeds (bean, chickpea)
pulleys
wheel and axle
screw nails
Lego or Mechano set (optional)
flashlight
globe
milk cartons
thermometer
barometer

APPENDIX "J"

Grades 7, 8 and 9

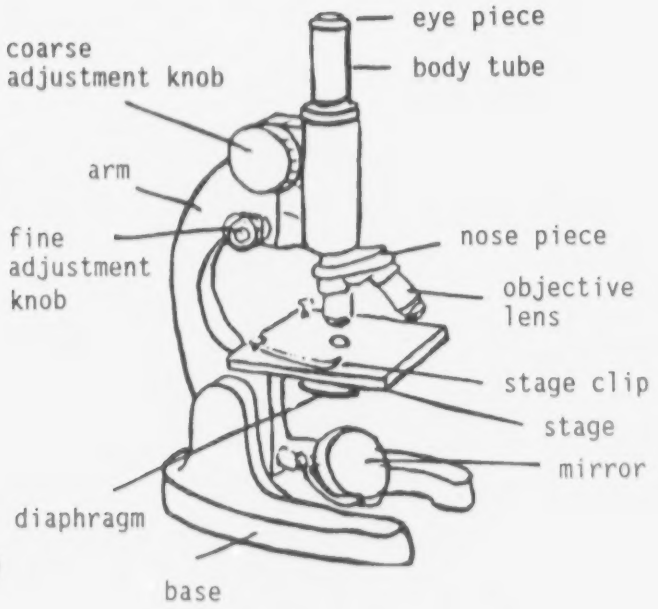
microscope
microscope slides, cover slips
hand lenses
yeast
thermometers
sugar
yo-yo
pendulum
light bulb
aquariums
flashlight
lens
glass prism
beakers
test tubes
variable size containers
protractor
drinking straws
tape
rubbing alcohol
food colouring
iron filings
mineral set
alum

spring scales
prepared slides of animal and plant cells
slides of blood cells
stop watch
paper clips
newsprint
fan
maps of Canada
map showing Continental Shelf
sand
soil
burners
ring stand
ring
clamps
bimetallic strip
bromothymal blue
litmus paper
pHydrion paper
household soaps, cleansers
shampoo
modelling clay
pulleys
protractor
spring scales
balance scale
gram weight set

APPENDIX "K"

THE MICROSCOPE

The microscope is an essential instrument in the study of living organisms because it enables the student to see things that are too small to be seen with the naked eye. The microscope the student uses in the science class is called a compound microscope because it has more than one lens. The part the student looks through is called the eyepiece and usually has a magnification power of 10X. This means that the object being viewed is enlarged ten times. The lenses attached to the nosepiece are called objective lenses. The number stamped on each lens indicates its magnification. For instance, if the eyepiece magnification is 10X, the total magnification of the microscope is (10X) x (10X) or 100 times.



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These procedures should be followed when using the microscope:

1. Carry the microscope with both hands, one hand under the base, and the other on the arm.
2. Stand facing a light source and set the microscope on the table with the arm toward you.
3. Turn the objective lens with the smallest magnification until it clicks into place under the body tube.
4. While looking through the eyepiece, adjust the diaphragm and the mirror so that the greatest amount of light is coming through the opening in the stage.
5. Place the prepared slide on the stage. Centre the specimen over the opening in the stage and use the stage clips to hold the slide in place.
6. Always look at the microscope from the side as you are using the coarse adjustment knob to lower the body tube until it almost reaches the slide. This will prevent you from breaking the slide and/or damaging the lens.
7. Look through the eyepiece, observe the specimen and slowly raise the body tube until the specimen comes into focus.
8. Always view the specimen with both eyes open. This will prevent eyestrain and allows you to make sketches of your observation without losing sight of the specimen.

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9. Make certain that the body tube is raised, before swinging the high-powered objective into place, so that the lens does not hit the slide.

10. Keep the microscope clean of dust, dirt and spilled fluids. Use lens paper for cleaning the lenses to avoid scratching them.

    To prepare a wet mount place the specimen in the middle of a clean microscope slide. (The specimen must be thin enough to allow light to pass through it).

Place a drop of water on the specimen (use a medicine dropper).

Place one side of a clean cover slip at the edge of the drop of water. Slowly lower the cover slip over the specimen and water. (This will prevent air bubbles from forming over the specimen).

RESPONSE QUESTIONNAIRE FOR K-9 SCIENCE PROGRAM OF STUDIES

Please return this questionnaire by January 15, 1992 to the:

Science Consultant
Curriculum Services
Manitoba Education and Training
411-1181 Portage Avenue
Winnipeg, Manitoba R3G 0T3

Please respond to each question in the space provided. (Attach extra sheets if more space is required). Use the page references when making specific comments.

1. Does the guide provide you with sufficient information as to nature and scope of the science program?

_____

_____

2. Are you able to adequately cover the stated objectives within the available class time?

_____

_____

3. Are your students capable of achieving the objectives listed in the unit(s)?

_____

_____

4. Is there sufficient variety in the activities to allow all students to take part in the program?

_____

5. Which activities are too simple or too difficult for the intended grade level?

_____

_____

6. Which activities do not seem to work well?

_____

_____

...../2

7. Which activities require clearer directions?

_____

_____

8. Are there sufficient material resources in your school to enable you to adequately teach the program?

_____

_____

9. Is there difficulty in obtaining science materials in order to carry out the activities?

_____

10. Do the students enjoy or appreciate the program?

_____

_____

11. What are some specific features of the program with which you are pleased?

_____

_____

12. Within the framework of the revised program, please make suggestions which, in your opinion, may result in significant improvements.

_____

_____

_____

_____

_____

NAME: _____ SCHOOL: _____

GRADE: _____ PHONE: _____

THANK YOU FOR YOUR ASSISTANCE.